REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION / AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) TR 88-09	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION 1. NAVENVPREDRSCHFAC 2. Science Applics Intnl Corp 6b. OFFICE SYMBOL (*If applicable*)	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (*City, State, and ZIP Code*) 1. Monterey, CA 93943-5006 2. Monterey, CA 93940	7b. ADDRESS (*City, State, and ZIP Code*)
8a. NAME OF FUNDING / SPONSORING ORGANIZATION Commander, Naval Oceanography Command 8b. OFFICE SYMBOL (*If applicable*)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER N00228-84-D-3187
8c. ADDRESS (*City, State, and ZIP Code*) Stennis Space Center, MS 39529-5000	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO. DN656794

11. TITLE (*Include Security Classification*)
Severe Weather Guide - Mediterranean Ports - 25. Valencia (U)

12. PERSONAL AUTHOR(S)
Perryman, Dennis C. (NAVENVPREDRSCHFAC)

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (*Year, Month, Day*)	15. PAGE COUNT
Final	FROM 9/13/84 TO 3/28/88	1988, August	60

16. SUPPLEMENTARY NOTATION
Funding source: O&M,N-1

17 COSATI CODES		
FIELD	GROUP	SUB-GROUP
04	02	

18. SUBJECT TERMS (*Continue on reverse if necessary and identify by block number*)
Storm haven; Mediterranean meteorology; Valencia port; Mediterranean oceanography

19. ABSTRACT (*Continue on reverse if necessary and identify by block number*)

This handbook for the port of Valencia, one in a series of severe weather guides for Mediterranean ports, provides decision-making guidance for ship captains whose vessels are threatened by actual or forecast strong winds, high seas, restricted visibility or thunderstorms in the port vicinity. Causes and effects of such hazardous conditions are discussed. Precautionary or evasive actions are suggested for various vessel situations. The handbook is organized in four sections for ready reference: general guidance on handbook content and use; a quick-look captain's summary; a more detailed review of general information on environmental conditions; and an appendix that provides oceanographic information.

20. DISTRIBUTION / AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED
22a. NAME OF RESPONSIBLE INDIVIDUAL Perryman, Dennis C.	22b. TELEPHONE (*Include Area Code*) (408) 647-4709 / 22c. OFFICE SYMBOL O&M,N-1

DD FORM 1473, 84 MAR 83 APR edition may be used until exhausted. All other editions are obsolete.

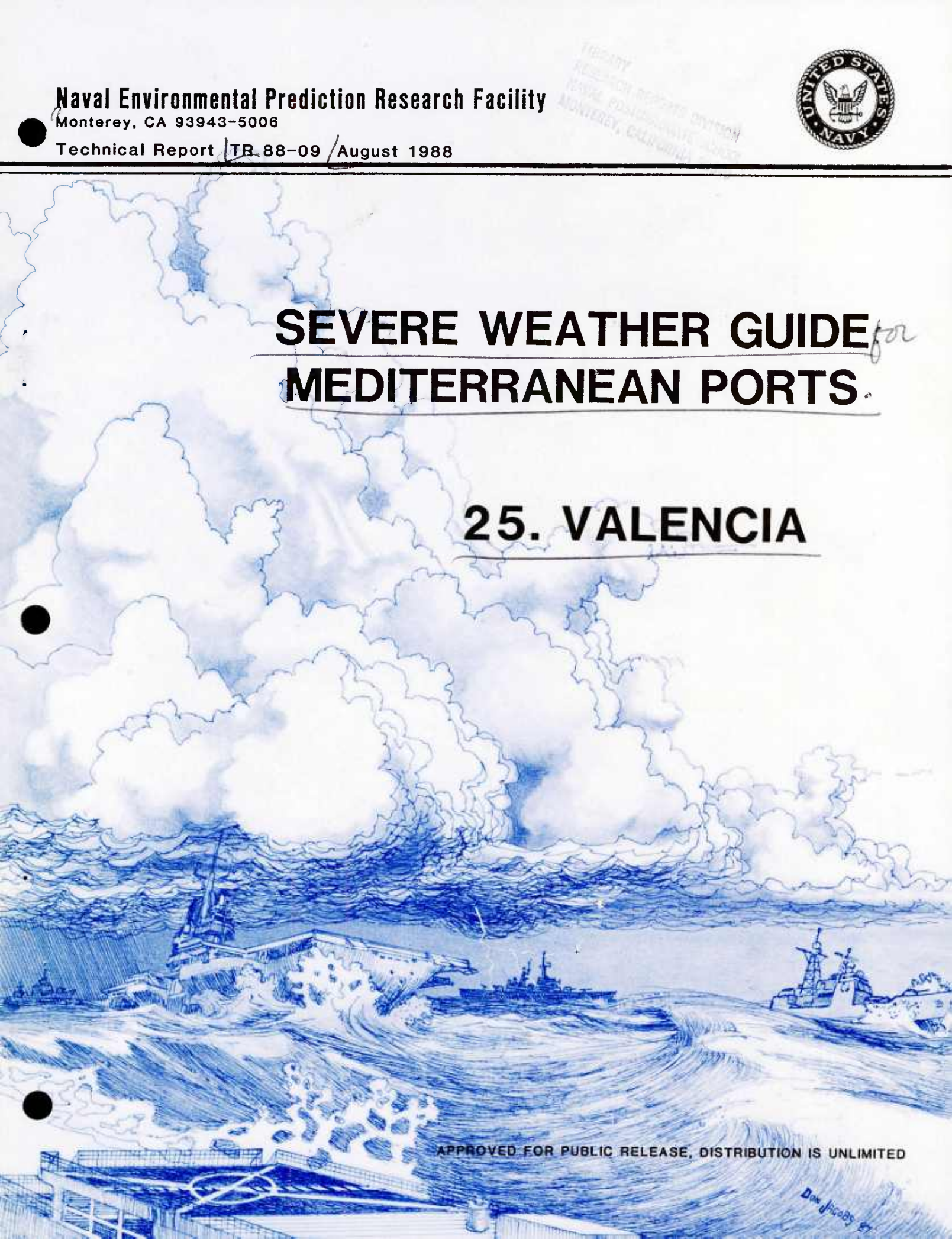
AN (1) AD-A202 283
FG (2) 040200
FG (2) 080300
CI (3) (U)
CA (5) SCIENCE APPLICATIONS INTERNATIONAL CORP MONTEREY CA
TI (6) Severe Weather Guide - Mediterranean Ports - 25. Valencia.
TC (8) (U)
DN (9) Final rept. 13 Sep 84-28 Mar 88.
AU (10) Perryman, Dennis C.
RD (11) Aug 1988
PG (12) 65
CT (15) N00228-84-D-3187
RN (18) NEPRF-TR-88-09
RC (20) Unclassified report
DE (23) *PORTS, (FACILITIES), HANDBOOKS, HAZARDS, LIMITATIONS, MEDITERRANEAN SEA, OCEANOGRAPHIC DATA, THUNDERSTORMS, VISIBILITY, WIND, SPAIN, WEATHER, ADVERSE CONDITIONS, SHIPS, OPERATION.
DC (24) (U)
ID (25) WUDN656794, *Valencia(Spain), *Severe weather.
IC (26) (U)
AB (27) This handbook for the port of Valencia, one in a series of severe weather guides for Mediterranean ports, provides decision-making guidance for ship captains whose vessels are threatened by actual or forecast strong winds , high seas, restricted visibility or thunderstorms in the port vicinity. Causes and effects of such hazardous conditions are discussed. Precautionary or evasive actions are suggested for various vessel situations. The handbook is organized in four sections for ready reference: general guidance on handbook content and use; a quick-look captain's summary; a more detailed review of general information on environmental conditions; and an appendix that provides oceanographic information. (fr)
AC (28) (U)
DL (33) 01
SE (34) F
ZP (35) A12277

Naval Environmental Prediction Research Facility
Monterey, CA 93943-5006

Technical Report TR 88-09 August 1988

SEVERE WEATHER GUIDE for MEDITERRANEAN PORTS

25. VALENCIA



CONTENTS

FOREWORD

This handbook on Mediterranean Ports was developed as part of an ongoing effort at the Naval Environmental Prediction Research Facility to create products for direct application to Fleet operations. The research was conducted in response to Commander Naval Oceanography Command (COMNAVOCEANCOM) requirements validated by the Chief of Naval Operations (OP-096).

As mentioned in the preface, the Mediterranean region is unique in that several areas exist where local winds can cause dangerous operating conditions. This handbook will provide the ship's captain with assistance in making decisions regarding the disposition of his ship when heavy winds and seas are encountered or forecast at various port locations.

Readers are urged to submit comments, suggestions for changes, deletions and/or additions to Naval Oceanography Command Center (NAVOCEANCOMCEN), Rota with a copy to the oceanographer, COMSIXTHFLT. They will then be passed on to the Naval Environmental Prediction Research Facility for review and incorporation as appropriate. This document will be a dynamic one, changing and improving as more and better information is obtained.

W. L. SHUTT
Commander, U.S. Navy

PORT INDEX

The following is a tentative prioritized list of Mediterranean Ports to be evaluated during the five-year period 1988-92, with ports grouped by expected year of the port study's publication. This list is subject to change as dictated by circumstances and periodic review.

1988 NO.	PORT
1	GAETA, ITALY
2	NAPLES, ITALY
3	CATANIA, ITALY
4	AUGUSTA BAY, ITALY
5	CAGLIARI, ITALY
6	LA MADDALENA, ITALY
7	MARSEILLE, FRANCE
8	TOULON, FRANCE
9	VILLEFRANCHE, FRANCE
10	MALAGA, SPAIN
11	NICE, FRANCE
12	CANNES, FRANCE
13	MONACO
14	ASHDOD, ISRAEL
15	HAIFA, ISRAEL
16	BARCELONA, SPAIN
17	PALMA, SPAIN
18	IBIZA, SPAIN
19	POLLENSA BAY, SPAIN
20	LIVORNO, ITALY
21	LA SPEZIA, ITALY
22	VENICE, ITALY
23	TRIESTE, ITALY
24	CARTAGENA, SPAIN
25	VALENCIA, SPAIN

1989	PORT
	SAN REMO, ITALY
	GENOA, ITALY
	PALERMO, ITALY
	MESSINA, ITALY
	TAORMINA, ITALY
	PORTO TORRES, ITALY
	BENIDORM, SPAIN
	TANGIER, MOROCCO

1990	PORT
	TARANTO, ITALY
	ROTA, SPAIN
	SOUDA BAY, CRETE
	PORT SAID, EGYPT
	ALEXANDRIA, EGYPT
	ALGIERS, ALGERIA
	TUNIS, TUNISIA
	GULF HAMMAMET, TUNISIA
	GULF OF GABES, TUNISIA

1991	PORT
	PIRAEUS, GREECE
	KALAMATA, GREECE
	THESSALONIKI, GREECE
	CORFU, GREECE
	KITHIRA, GREECE
	VALETTA, MALTA
	LARNACA, CYPRUS

1992	PORT
	ANTALYA, TURKEY
	ISKENDERUN, TURKEY
	IZMIR, TURKEY
	GOLCUK, TURKEY
	ISTANBUL, TURKEY
	GULF OF SOLLUM
	SPLIT, YUGOSLAVIA
	DUBROVNIK, YUGOSLAVIA

PREFACE

Environmental phenomena such as strong winds, high waves, restrictions to visibility and thunderstorms can be hazardous to critical Fleet operations. The cause and effect of several of these phenomena are unique to the Mediterranean region and some prior knowledge of their characteristics would be helpful to ship's captains. The intent of this publication is to provide guidance to the captains for assistance in decision making.

The Mediterranean Sea region is an area where complicated topographical features influence weather patterns. Katabatic winds will flow through restricted mountain gaps or valleys and, as a result of the venturi effect, strengthen to storm intensity in a short period of time. As these winds exit and flow over port regions and coastal areas, anchored ships with large 'sail areas' may be blown aground. Also, hazardous sea state conditions are created, posing a danger for small boats ferrying personnel to and from port. At the same time, adjacent areas may be relatively calm. A glance at current weather charts may not always reveal the causes for these local effects which vary drastically from point to point.

Because of the irregular coast line and numerous islands in the Mediterranean, swell can be refracted around such barriers and come from directions which vary greatly with the wind. Anchored ships may experience winds and seas from one direction and swell from a different direction. These conditions can be extremely hazardous for tendered vessels. Moderate to heavy swell may also propagate outward in advance of a storm resulting in uncomfortable and sometimes dangerous conditions, especially during tending, refueling and boating operations.

This handbook addresses the various weather conditions, their local cause and effect and suggests some evasive action to be taken if necessary. Most of the major ports in the Mediterranean will be covered in the handbook. A priority list, established by the Sixth Fleet, exists for the port studies conducted and this list will be followed as closely as possible in terms of scheduling publications.

RECORD OF CHANGES

CHANGE NUMBER	DATE OF CHANGE	DATE ENTERED	PAGE NUMBER	ENTERED BY

1. GENERAL GUIDANCE

1.1 DESIGN

This handbook is designed to provide ship captains with a ready reference on hazardous weather and wave conditions in selected Mediterranean harbors. Section 2, the captain's summary, is an abbreviated version of section 3, the general information section intended for staff planners and meteorologists. Once section 3 has been read, it is not necessary to read section 2.

1.1.1 Objectives

The basic objective is to provide ship captains with a concise reference of hazards to ship activities that are caused by environmental conditions in various Mediterranean harbors, and to offer suggestions for precautionary and/or evasive actions. A secondary objective is to provide adequate background information on such hazards so that operational forecasters, or other interested parties, can quickly gain the local knowledge that is necessary to ensure high quality forecasts.

1.1.2 Approach

Information on harbor conditions and hazards was accumulated in the following manner:

A. A literature search for reference material was performed.
B. Cruise reports were reviewed.
C. Navy personnel with current or previous area experience were interviewed.
D. A preliminary report was developed which included questions on various local conditions in specific harbors.
E. Port/harbor visits were made by NEPRF personnel; considerable information was obtained through interviews with local pilots, tug masters, etc; and local reference material was obtained.
F. The cumulative information was reviewed, combined, and condensed for harbor studies.

1.1.3 Organization

The Handbook contains two sections for each harbor. The first section summarizes harbor conditions and is intended for use as a quick reference by ship captains, navigators, inport/at sea OOD's, and other interested personnel. This section contains:

A. a brief narrative summary of environmental hazards,
B. a table display of vessel location/situation, potential environmental hazard, effect-precautionary/evasion actions, and advance indicators of potential environmental hazards,
C. local wind wave conditions, and
D. tables depicting the wave conditions resulting from propagation of deep water swell into the harbor.

The swell propagation information includes percent occurrence, average duration, and the period of maximum wave energy within height ranges of greater than 3.3 feet and greater than 6.6 feet. The details on the generation of sea and swell information are provided in Appendix A.

The second section contains additional details and background information on seasonal hazardous conditions. This section is directed to personnel who have a need for additional insights on environmental hazards and related weather events.

1.2 CONTENTS OF SPECIFIC HARBOR STUDIES

This handbook specifically addresses potential wind and wave related hazards to ships operating in various Mediterranean ports utilized by the U.S. Navy. It does not contain general purpose climatology and/or comprehensive forecast rules for weather conditions of a more benign nature.

The contents are intended for use in both previsit planning and in situ problem solving by either mariners or environmentalists. Potential hazards related to both weather and waves are addressed. The oceanographic information includes some rather unique information relating to deep water swell propagating into harbor shallow water areas.

Emphasis is placed on the hazards related to wind, wind waves, and the propagation of deep water swell into the harbor areas. Various vessel locations/situations are considered, including moored, nesting, anchored, arriving/departing, and small boat operations. The potential problems and suggested precautionary/evasive actions for various combinations of environmental threats and vessel location/situation are provided. Local indicators of environmental hazards and possible evasion techniques are summarized for various scenarios.

CAUTIONARY NOTE: In September 1985 Hurricane Gloria raked the Norfolk, VA area while several US Navy ships were anchored on the muddy bottom of Chesapeake Bay. One important fact was revealed during this incident: Most all ships frigate size and larger dragged anchor, some more than others, in winds of over 50 knots. As winds and waves increased, ships 'fell into' the wave troughs, BROADSIDE TO THE WIND and become difficult or impossible to control.

This was a rare instance in which several ships of recent design were exposed to the same storm and much effort was put into the documentation of lessons learned. Chief among these was the suggestion to evade at sea rather than remain anchored at port whenever winds of such intensity were forecast.

2. CAPTAIN'S SUMMARY

The city of Valencia is located on the western edge of the Balearic Sea in the Golfo de Valencia. It is situated on the northern side of a low-lying plain known as the Huerte and is only 43 ft (13 m) above sea level (Figure 2-1). The plain extends some 20 n mi southward along the coast and about 100 n mi inland. The port is situated on a section of east-facing coastline and, therefore, is exposed to the wind regimes of the western Mediterranean.

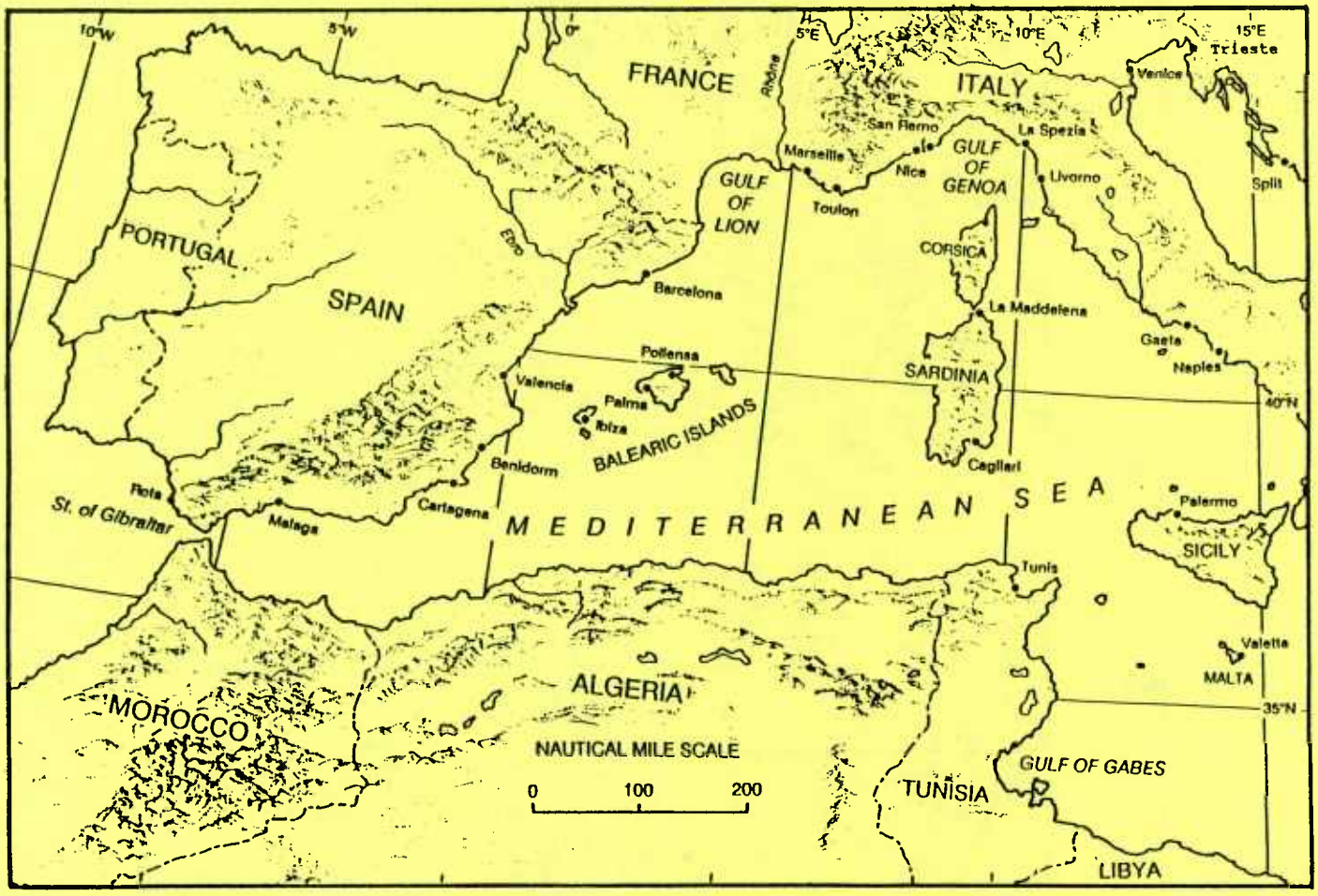


Figure 2-1. Western Mediterranean Sea.

The Port of Valencia is located at 39° 27'N 0° 19'W (Figure 2-2). The entrance to the port faces south-southeast; it is 853 ft (260 m) wide with a low water depth of 49 ft (15 m). Entrance is made via the dredged channel between the south breakwater and the east breakwater (FICEURLANT, 1987).

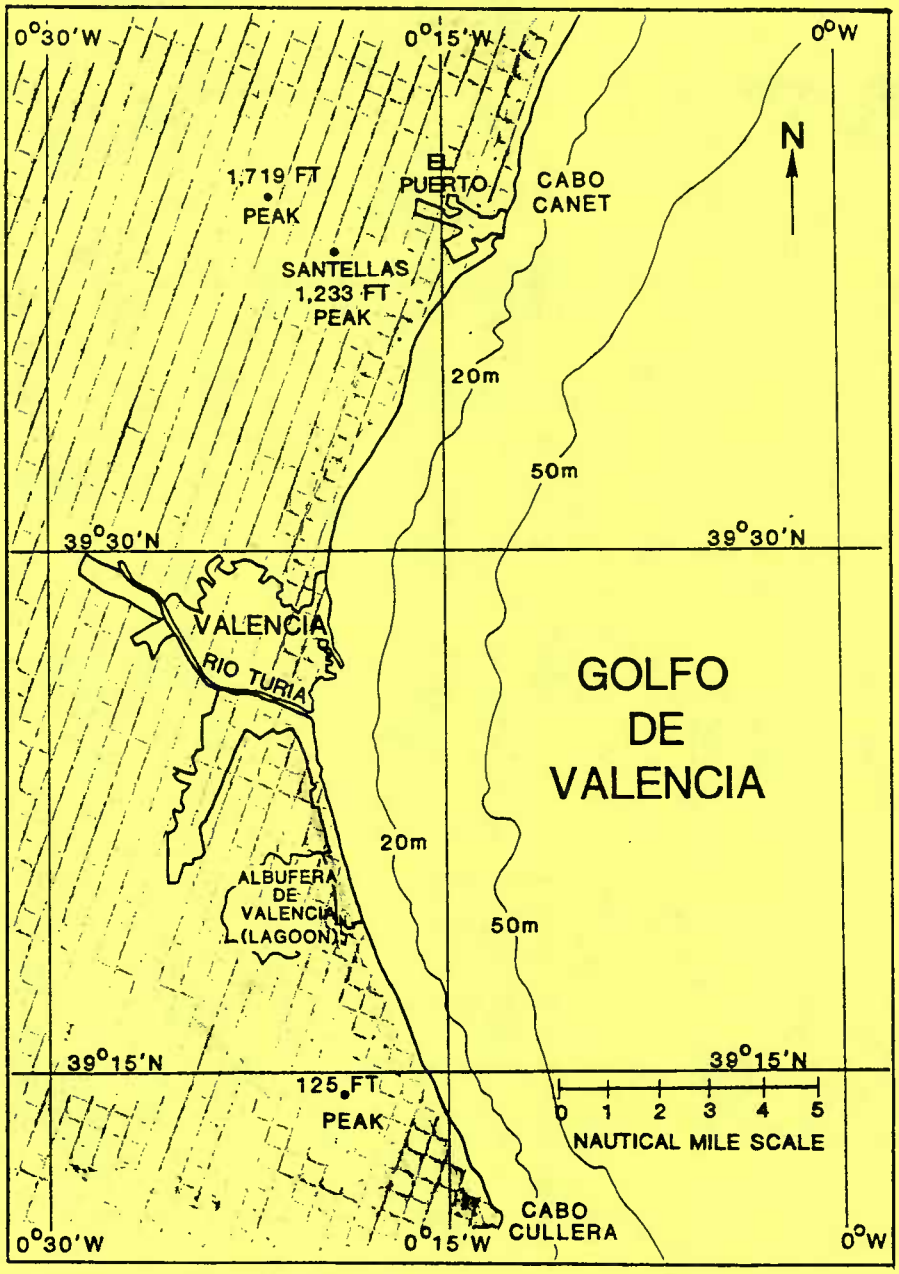


Figure 2-2. Gulf of Valencia.

Valencia has a medium-sized artificial harbor containing an outer harbor, an inner harbor consisting of three basins with berthing facilities for large vessels, and a roadstead anchorage for large vessels (Figure 2-3). The harbor is liable to silting; continuous dredging is necessary to maintain depths.

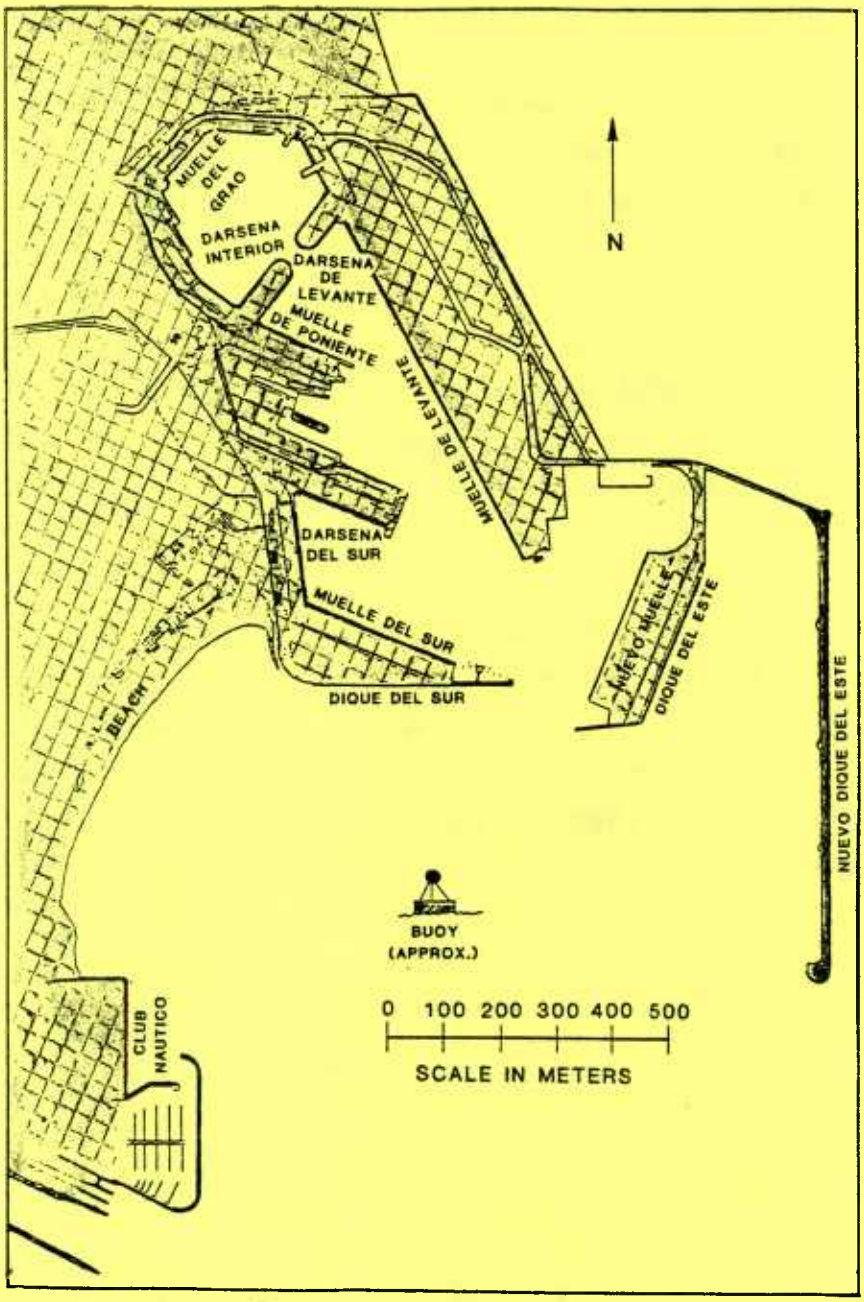


Figure 2-3. Port of Valencia.

A 66 ft (20 m) deep anchorage is located 3/4 n mi east of the breakwater. Holding ground is of clay, mud, sand, algae and shells and is considered very good. This anchorage, however, is exposed to easterly winds. Another anchorage is located inside the breakwater near the center buoy (Figure 2-3). Depth is 39 ft (12 m) and holding ground is similar to that of the outer anchorage (very good).

The inner harbor of the Port of Valencia is well protected from most sea and swell waves. The south-southeast facing harbor entrance occasionally allows waves from the southern quadrant to pass through, affecting vessels moored in the outermost basins. Ships in the Darsena Interior basin will experience little or no motion. Local mariners indicate that because of the infrequency of high winds and waves at Valencia, protective measures are rarely necessary for ships at berth.

The inner anchorage is, of course, preferred over the outer anchorage because of the possibility of easterly winds (Levante) which generate 12 to 14 ft swell on two or three occasions each winter. Each occurrence can last three or four days and is usually accompanied by 25 kt winds and rainshowers.

Nuevo Muelle can handle ships up to carrier size. Smaller craft berth at Muelle del Sur, Muelle del Grao and Muelle de Poniente. The fleet landing is located in front of the marine station next to Muelle del Grao.

There are no astronomical tides in the Valencia harbor. On rare occasions, tidal changes up to two feet can be caused by atmospheric pressure or by southeast to southwest gales.

Just outside the harbor entrance a 1.5 kt current sets southward along the coast.

Local port personnel indicate that hoisting anchor to maintain station, deploying extra anchors or shifting anchorages due to hazardous conditions is extremely rare. Wind and waves within the harbor rarely cause conditions which would require protective measures for ships at berth. On rare occasions, doubling of lines may be necessary.

Specific hazardous environmental conditions, vessel situations, and suggested precautionary/evasive action scenarios for the Port of Valencia are summarized in Table 2-1.

Table 2-1. Summary of hazardous environmental conditions for the Port of Valencia, Spain.

HAZARDOUS CONDITION	INDICATORS OF POTENTIAL HAZARD	VESSEL LOCATION/ SITUATION AFFECTED	EFFECT - PRECAUTIONARY/EVASIVE ACTIONS
1. E'ly/NE'ly - Levante Can cause high waves at anchorage. * Occurs year-round, strongest in winter and spring. * Caused by Azores high extending into Spain or from low pressure system to the south of the Balearic Islands. * In cool seasons, usually accompanied by low clouds and rain. * E'ly to SE'ly Levante will often precede cold fronts in winter/early spring.	Advance warning * A low NE or ENE swell can be observed 12 hrs in advance of wind onset. NOTE: The swell can also be caused by Mistral winds over the Gulf of Lion. * If an intense low is south of the Balearics, gale Levante winds can be expected at the anchorage. * Synoptic pattern has a high over Europe and a low over North Africa.	(1) Moored-inner harbor.	(a) Local mariners indicate that protective measures are rarely necessary for ships in the harbor. * Ships with large sail area may need extra lines in an intense Levante episode. * On rare occasions ships berthed near the harbor entrance may feel some motion due to waves from SE Levante (associated with a cold front approaching). (b) Although rare, wind chill can be a factor in winter.
		(2) Outer anchorage.	(a) High winds/waves at outer anchorage may force ships to sortie to the open sea. * Due to long fetch from ENE, 12 to 14 ft swell is possible even with local winds of only 25 kt. * 25 to 35 kt winds with occasional rainshowers can last for three or four days. (b) Although rare, wind chill can be a factor in winter.
		(3) Arriving/departing.	(a) Use caution on departure as high waves can be encountered just past the end of Nuevo Dique Del Este. (b) Although rare, wind chill can be a factor in winter.
		(4) Small boats.	(a) Inner harbor operations will be minimally affected. * Runs to/from the outer anchorage may be curtailed due to hazardous winds/waves at the anchorage. * Winds can change direction quickly, especially in winter, causing waves to cross at dangerous angles to the winds and create hazardous conditions for small boats. (b) Although rare, wind chill can be a factor in winter.

Table 2-1. (Continued)

HAZARDOUS CONDITION	INDICATORS OF POTENTIAL HAZARD	VESSEL LOCATION/ SITUATION AFFECTED	EFFECT - PRECAUTIONARY/EVASIVE ACTIONS
2. SW'ly to W'ly - Vendaval Precedes cold fronts. * Can be gale force (34 to 47 kt) with well-defined cold front. * Precipitation usually accompanies the Vendaval/cold front system but can be delayed 12 hrs after onset of Vendaval.	Advance warning * Any cold front approaching Spain's east coast from the west has the potential to cause strong Vendaval winds. Note that fronts will weaken as they approach the coast but will intensify once reaching the coast. * Another cause of Vendaval winds is when the Azores High intensifies, resulting in a steepening gradient between it and lows approaching the British Isles. During these events, winds at Valencia will peak during late morning (0900L-noon) and again at 1400L-1500L.	(1) Moored-inner harbor.	(a) Local mariners indicate that protective measures are rarely necessary for ships in the harbor. * Ships with large sail area may need extra lines during an intense Vendaval episode. * Ships berthed near the harbor entrance may experience some motion due to waves from the south but this is usually of short duration.
		(2) Outer anchorage.	(a) In extremely rare cases high winds/waves at outer anchorage may force ships to sortie to the open sea. * Intense Vendaval episodes are usually of short duration (3-6 hrs) and waves do not build to great heights. * A more southerly Vendaval direction will bring higher waves to the outer anchorage than will southwest or westerly Vendavals due to fetch distances.
		(3) Arriving/departing.	(a) Caution must be used on departure as waves outside the protected inner harbor will be much higher than in the harbor. * If the Vendaval is southerly, waves will be felt while still inside the breakwater and wave heights will sharply increase outside the breakwater area. * If the Vendaval is southwest or west, waves will be at a minimum but winds will affect vessels which have large sail area.
		(4) Small boats.	(a) Inner harbor operations will be minimally affected. * Runs to/from the outer anchorage may be curtailed due to hazardous winds/waves at the anchorage. * If Vendaval is southerly, boat runs to/from ships anchored in the outer basin (still inside the breakwater) may be affected as some waves may penetrate the south-facing harbor entrance. * Winds can change direction quickly, especially in winter, causing waves to cross at dangerous angles to the winds and create hazardous conditions for small boats.

Table 2-1. (Continued)

HAZARDOUS CONDITION	INDICATORS OF POTENTIAL HAZARD	VESSEL LOCATION/ SITUATION AFFECTED	EFFECT – PRECAUTIONARY/EVASIVE ACTIONS
3. NW'ly winds - Poniente Those which follow cold fronts in the cool season are most intense (34 to 47 kt) and the most frequent of Ponientes. * Poniente winds can occur in other seasons when a high builds over Spain from the Atlantic. * Poniente winds can last for days in the Valencia area, averaging 15 kt with peaks to 30 kt. * During a strong, widespread episode, winds along Spain's east coast out to 50 n mi will be relatively light except near Valencia due to the area's low terrain. East of the 50 n mi zone, winds will be gale force (30+ kt).	Advance warning * The most intense Poniente winds will follow cool season cold fronts, but will also be of short duration. Any cold front will be followed by Poniente winds. * Large-scale pressure increases over Spain can be a signal of a persistent Poniente.	(1) Moored-inner harbor.	(a) Local mariners indicate that protective measures are rarely necessary for ships in the harbor. * Ships with large sail area may need extra lines during an intense Poniente episode. (b) Although rare, wind chill can be a factor in winter.
		(2) Outer anchorage.	(a) Wind sensitive operations will be hindered for ships at the anchorage. * Waves are minimal due to fetch limitations. * Winds can last for days, averaging 15 kt with peaks to 30 kt. (b) Although rare, wind chill can be a factor in winter.
		(3) Arriving/departing.	(a) Note that winds both north and south of Valencia may be less intense than at Valencia due to low terrain of the area. * An area from the coast to approximately 50 n mi offshore will have light winds except near Valencia. Winds east of the 50 n mi zone will also be strong. (b) Although rare, wind chill can be a factor in winter.
		(4) Small boats.	(a) Inner harbor operations will be minimally affected. * Runs to/from the outer anchorage may be curtailed due to hazardous winds/waves at the anchorage. * Winds can change direction quickly, especially in winter, causing waves to cross at dangerous angles to the winds and create hazardous conditions for small boats. (b) Although rare, wind chill can be a factor in winter.

Table 2-1. (Continued)

HAZARDOUS CONDITION	INDICATORS OF POTENTIAL HAZARD	VESSEL LOCATION/ SITUATION AFFECTED	EFFECT - PRECAUTIONARY/EVASIVE ACTIONS
4. NE'ly wind/waves - Mistral Swell from an event in the Gulf of Lion can extend as far south as Valencia. * Mistral outbreaks occur most frequently in late winter and early spring. * In rare cases (1-2 times a year), strong (25+ kt) Mistral winds will be felt in the Valencia area. * More often (4-5 times a year), long-period (15 sec) northeast swell, with or without the wind, will affect the anchorage area. Swell is usually less than 10 feet.	Advance warning * A strong Mistral event (40+ kt) in the Gulf of Lion will normally produce some swell in the Valencia area (see the Severe Weather Guide for Marseille or Toulon for details.	(1) Moored-inner harbor.	(a) Local mariners indicate that protective measures are rarely necessary for ships in the harbor.
		(2) Outer anchorage.	(a) High swell will more likely be a problem than high wind. * Wind and waves will be from same direction during Mistral events but long period (15 sec) swell may cause excessive motion on ships with critical response amplitudes. * If necessary, moving to a position south of the Balearics will lessen the effect of the swell.
		(3) Arriving/departing.	(a) Use caution on departure as the Mistral will have minimal effect in the harbor while high waves will be present just outside the breakwater. * A northerly or southerly departure will minimize the swell effect while an easterly heading from Valencia will put the swell on the beam.
		(4) Small boats.	(a) Inner harbor operations will be minimally affected. * Runs to/from the outer anchorage may be curtailed due to hazardous winds and/or swell at the anchorage. * Winds can change direction quickly, especially in winter, causing waves to cross at dangerous angles to the winds and create hazardous conditions.
5. Sea breeze - SE'ly 10 to 20 kt. * Occurs end of spring to early fall.	Advance warning * Onset daily about 1400; lasts until dark.	(3) Arriving/departing.	(a) During 1500-1900L maximum wind speed causes problems for large sail area ships entering/leaving the harbor.
		(4) Small boats.	(a) Generates three to five ft wind waves at the outer anchorages.

SEASONAL SUMMARY OF HAZARDOUS WEATHER CONDITIONS

(Much of this information has been adapted from Brody and Nestor, 1980).

WINTER (November through February):

* Easterly wind (Levante) can precede cold front or occur when low is south of Balearics.
* Southwesterly wind (Vendaval) may follow the Levante. Both winds can be in 30-35 kt range.
* Most common wind direction in winter is northwest 15 kt, occasionally 30 kt. Fetch is limited so waves are minimal.

SPRING (March through May):

* Early spring similar to winter. Sea breezes occur on warm days.
* Thunderstorms begin in April, one to two per month.

SUMMER (June through September):

* Thunderstorms possible throughout summer, one to two occurrences per month with infrequent gusts to 45 kt.

AUTUMN (October):

* Short transition season as winter weather returns by end of month.
* Thunderstorms occur two to three times in October.

NOTE: For more detailed information on hazardous weather conditions, see previous Summary Table in this section and Hazardous Weather Summary in Section 3.

REFERENCES

Brody, L.R. and M.J.R. Nestor, 1980: Regional Forecasting Aids for the Mediterranean Basin, NAVENVPREDRSCHFAC Technical Report TR 80-10. Naval Environmental Prediction Research Facility, Monterey, California 93941.

FICEURLANT, 1987: Port Directory for Valencia (1985), Spain. Fleet Intelligence Center Europe and Atlantic, Norfolk, Virginia.

3. GENERAL INFORMATION

The information in this section is intended for fleet meteorologists/oceanographers and staff planners. Paragraph 3.5 provides a general discussion of winds and weather and Table 3-1 presents a summary of hazards and actions by season.

3.1 Geographic Location

Valencia is located on the western edge of the Balearic Sea in the Golfo de Valencia. It is situated on a low-lying plain known as the Huerte, and is only 43 ft (13 m) above sea level (Figure 3-1). The plain extends some 20 n mi southward along the coast and about 100 n mi inland. The port is situated on a section of east-facing coastline and, therefore, is exposed to the wind regimes of the western Mediterranean.

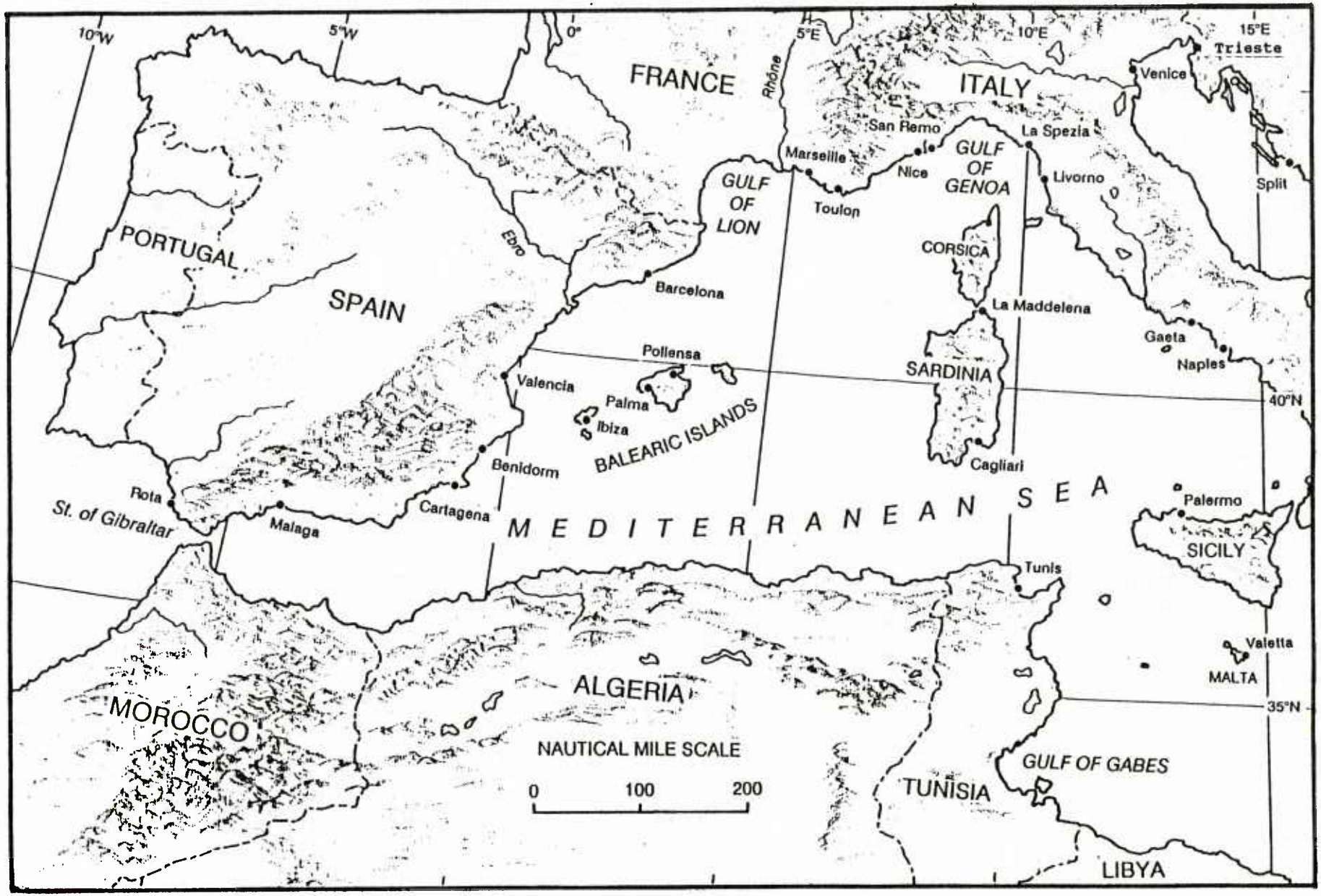


Figure 3-1. Western Mediterranean Sea.

The Port of Valencia is located at 39° 27'N 0° 19'W (Figure 3-2). The entrance to the port faces south-southeast; it is 853 ft (260 m) wide with a low water depth of 49 ft (15 m). Entrance is made via the dredged channel between the south breakwater and the east breakwater (FICEURLANT, 1987).

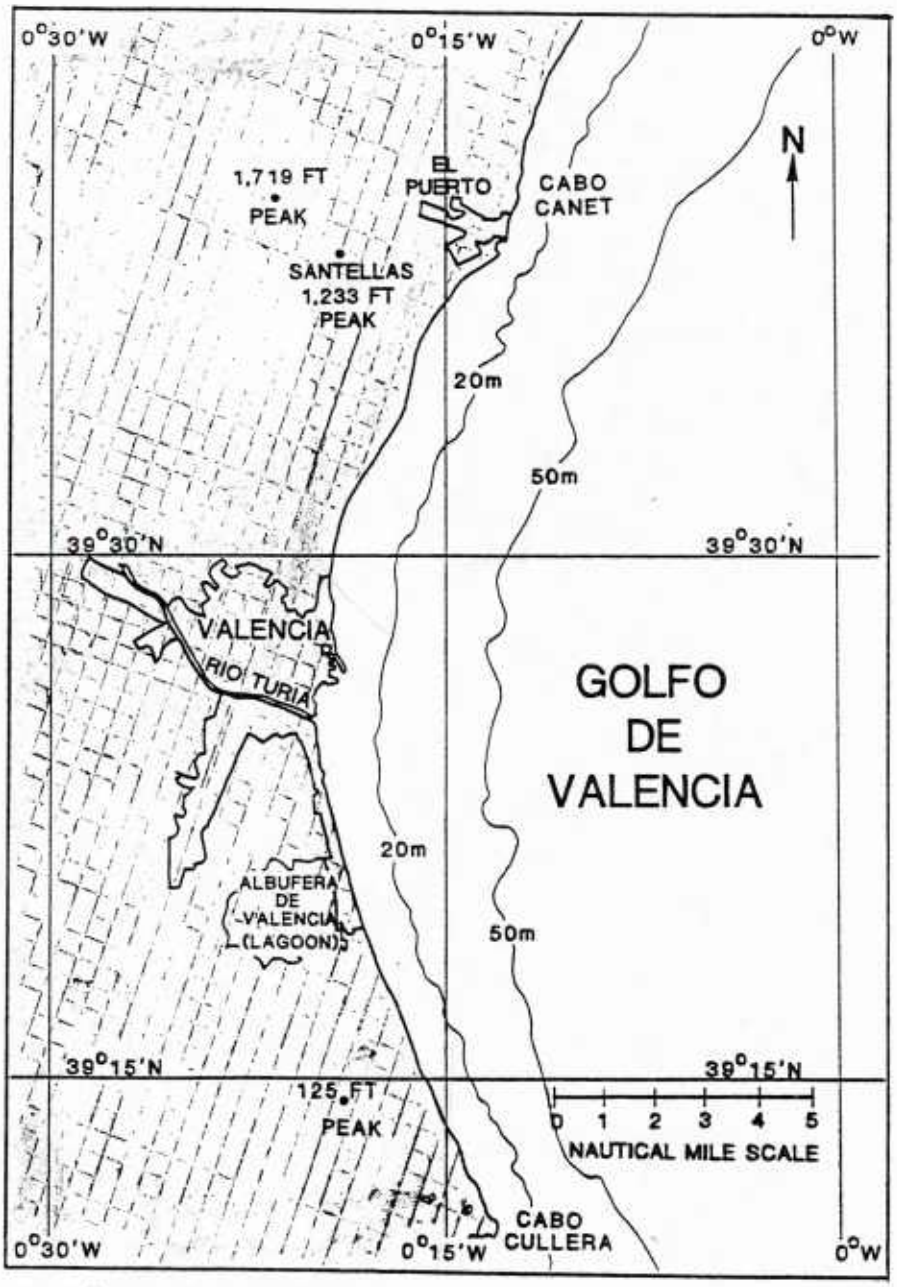


Figure 3-2. Gulf of Valencia.

Valencia has a medium-sized artificial harbor containing an outer harbor, an inner harbor consisting of three basins with berthing facilities for large vessels, and a roadstead anchorage for large vessels (Figure 3-3). The harbor is liable to silting; continuous dredging is necessary to maintain depths.

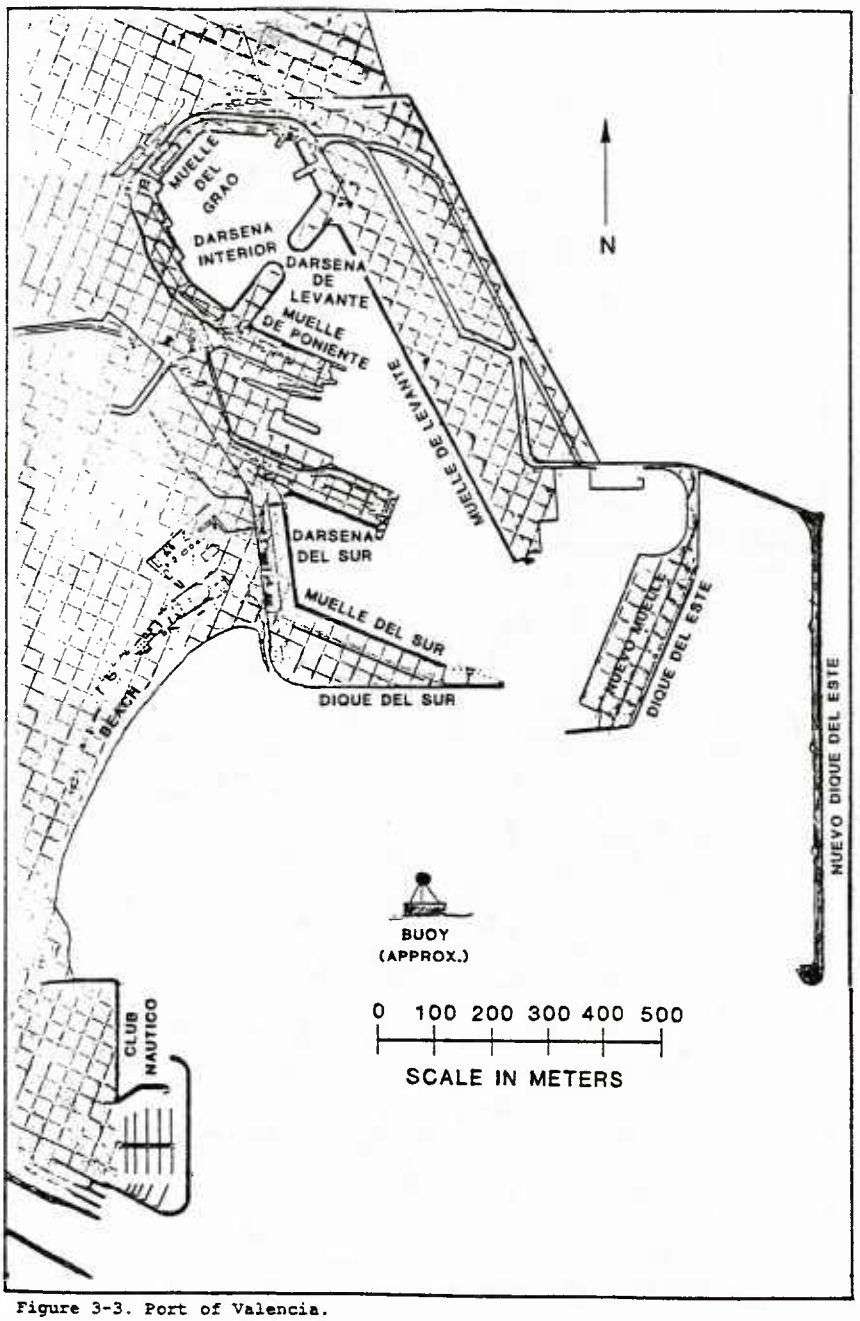


Figure 3-3. Port of Valencia.

A 66 ft (20 m) deep anchorage is located 3/4 n mi east of the breakwater. Holding ground is of clay, mud, sand, algae and shells and is considered very good. This anchorage, however, is exposed to easterly winds. Another anchorage is located inside the breakwater near the center buoy (Figure 3-3). The depth is 39 ft (12 m) and holding ground is similar to outer anchorage.

Nuevo Muelle can handle ships up to carrier size. Smaller craft berth at Muelle del Sur, Muelle del Grao and Muelle de Poniente. The fleet landing is located in front of the marine station next to Muelle del Grao.

There are no astronomical tides in the Valencia harbor. On rare occasions, tidal changes up to two feet can be caused by atmospheric pressure or by southeast to southwest gales.

Just outside the harbor entrance a 1.5 kt current sets southward along the coast.

3.2 Qualitative Evaluation of the Port of Valencia

The inner harbor of the Port of Valencia is well protected from most sea and swell waves. The south-southeast facing harbor entrance occasionally allows waves from the southern quadrant to pass through, affecting vessels moored in the outermost basins. Ships in the Darsena Interior Basin will experience little or no motion. Local mariners indicate that, because of the infrequency of high winds and waves at Valencia, protective measures are rarely necessary for ships at berth.

The inner anchorage is, of course, preferred over the outer anchorage because of the possibility of easterly winds (Levante) which generate 12 to 14 ft swell on two or three occasions during winter per year. Each occurrence can last three or four days and is usually accompanied by 25 kt winds and rainshowers.

3.3 Currents and Tides

A 1.5 kt current sets southward along the coast and is noticeable at the outer anchorage and at the harbor entrance. There are no astronomical tides at Valencia. On rare occasions, tidal changes due to large pressure changes can alter the tide level by one to two feet. Also, gale winds from the south quadrant will raise the tide level by 1 to 1 1/2 ft; however, this is a rare phenomenon.

3.4 Visibility

Visibility is normally greater than seven miles. There are times in December through March when visibility is reduced. This is usually when good weather has prevailed due to a high pressure center which has stagnated in the area. Zero visibility due to fog occurs one or two days per year in the morning hours and can last as long as seven hours.

3.5 Wind and Weather

Valencia is geographically situated in a nearly ideal area for mild climate and the weather is generally good year-round. The port and harbor area normally will not feel the full effects of most of the western Mediterranean wind regimes, such as the Mistral, Vendaval and Poniente. The Levante will, on occasion, cause problems at the outer anchorage. The following paragraphs discuss these winds and their effects on the Port of Valencia. Except where noted, this information is adapted from Brody and Nestor, 1980.

3.5.1 Levante

The Levante is an easterly or northeasterly wind that occurs in an area from the coast of southern France to west of the Strait of Gibraltar. It can occur as a result of several different weather patterns. The most typical situation is when the Azores High extends northeastward over Spain and southern France. With a large anticyclone over western Europe and relatively low pressure over the western Mediterranean, the Levante will be widespread. The Levante will also precede the arrival of a cold front from the Atlantic during the cool season (November through April), when a lee

depression or trough forms in the region off the Balearic Islands. A third situation is when an intense cyclone is south of the Balearics, and a gale force Levante can be expected along the east coast of Spain. Another pattern which results in the Levante is when a migratory low moves eastward in southern Spain to a position near the Greenwich Meridian. In this case, gale northeasterlies can be expected off the east coast of Spain as far east as Ibiza.

Levante wind speeds in the Valencia area are usually moderate (15 to 25 kt) and speeds greater than 33 kt are rare. Wind statistics show a consistent 15 to 20 percent occurrence of northeasterly winds in all months (Naval Weather Service, 1975) so the Levante can occur in any month; however, wind speeds tend to be higher in the cool season. In summer, haze and reduced visibility will often accompany the Levante, while during the other three seasons, cold fronts or depressions will bring low clouds and rain.

3.5.2 Vendaval

Vendaval winds are southwesterlies which precede cold fronts and are most likely to occur in the cool season with gale force intensity (34 to 47 kt). Precipitation usually accompanies the Vendaval/cold front system but can be delayed by as much as 12 hours after the onset of the Vendaval.

Strong southwesterly to westerly winds are common at Valencia. The synoptic situation producing these winds is characterized by an intensifying high that lies south of the Azores, with a deep low in the Atlantic approaching the British Isles and the coast of

Europe, thereby resulting in a steepening pressure gradient between the high and low. During these events, maximum winds at Valencia occur in late morning (0900L-Noon) and again in mid-afternoon (1400L-1500L).

3.5.3 Poniente

The Poniente is a northwesterly wind behind the cold front and usually occurs in the cool season; however, northwesterlies often occur in other seasons when high pressure builds in from the Atlantic. Consequently, the Poniente can be expected year round with peak frequency and peak intensity during the cool season. In winter, the Azores High is displaced southward, resulting in northwesterlies which will last for days in the Valencia area. During these episodes, winds will average 15 kt with peaks to 30 kt.

When strong northwesterly flow crosses Spain, a well-defined lee trough is established along the eastern Spanish coast between Barcelona and Valencia. This causes winds to be relatively light (20 kt) along the coast and out to 50 n mi except near Valencia. Because of the low terrain, a funneling effect will produce gale force northwesterlies or westerlies in the vicinity of the harbor. Gale force northwesterlies also will be occurring to the east of the 50 n mi zone. Strong and gusty northwesterlies also typically occur along the coast between Barcelona and Valencia following the passage of an upper-level trough.

3.5.4 Mistral

The Mistral is a cold, strong northwesterly to north-northwesterly wind flowing offshore across the entire coast of the Gulf of Lion, often extending

southward along the coast of Spain. (For a complete description of the Mistral, see the Severe Weather Guide for Marseille or Toulon.) Although rare, strong winds in the Valencia area caused by the Mistral will reach 25 kt from the northeast, and northeasterly swell, with or without the winds, will occasionally affect the outer anchorage area.

3.5.5 Sea Breeze

A summer sea breeze, known locally as the Garbi, blows between 10 and 15 kt from the southeast. On infrequent occasions it can reach 20 kt. The onset normally occurs at 1400 local time and ends at dusk. There is rarely a nocturnal land breeze.

3.6 Seasonal Summary of Hazardous Weather Conditions.

The seasonal patterns in the western Mediterranean area will vary in response to the movement of the Azores High. This high moves southward during winter, allowing low pressure systems to move in over Europe. The high builds northward as summer approaches and storms affecting the western Mediterranean become less frequent; in the middle of summer they are nearly non-existent. Much of the information in this section is adapted from Brody and Nestor, 1980.

A. Winter (November through February)

The easterly (Levante) wind is stronger in winter and spring. It will precede the arrival of cold fronts from the Atlantic. When there is an intense low south of the Balearic Islands, gale Levante winds can be expected along Spain's entire eastern coast. The pre-frontal Levante may turn into a southwesterly wind (Vendaval) and reach gale force in wintertime. Once the

front has passed, the winds will turn northwesterly (Poniente). Because the inner harbor areas of Valencia are protected from most wave conditions, only wind sensitive operations are affected during these events. The outer anchorage will, however, be exposed to 12 or 14 ft (4 m) waves during a strong Levante or a Vendaval episode.

The most common wind direction in winter is from the northwest. These winds can last for days, averaging 15 kt, with occasional peaks to 30 kt. Because of fetch limitation, high seas usually do not hamper operations.

Below freezing temperatures are recorded only on an average of two days per year (most likely in February); however, the minimum recorded temperature at Valencia is 19° F (-7° C) and could, if combined with high winds, cause hazardous wind chill.

Precipitation amounts at Valencia are not great, with a yearly average of 15 inches. Forty percent of the yearly total occurs in September, October and November.

B. Spring (March through May)

Springtime in the western Mediterranean is noted for periods of stormy winter-like weather alternating with false starts of summer. Temperatures are warming, and storm events are decreasing in both strength and frequency. Sea breezes begin to occur on warm days. Thunderstorms appear in April.

C. Summer (June through September)

Summers are characterized by the almost constant light to moderate wind. Both the Levante and

the Poniente are common in summer, although neither is very intense. Temperatures are warm with a maximum recorded temperature of 107° F (42° C). Precipitation amounts are minimal until September when the rainy season begins. The sea breeze regime is a daily occurrence except when interrupted by either the Levante or the Vendaval.

Thunderstorms continue to occur throughout summer. One or two occurrences can be expected each month. These storms are usually preceded by hot temperatures and southerly winds. In rare instances, gusts to 45 kt and hail can accompany them.

D. Autumn (October)

The autumn season is a short, transitional period lasting only for the month of October. By month's end, an abrupt change to winter-like weather has taken place. Thunderstorms occur two to three times in October.

3.7 Local Indicators of Hazardous Weather Conditions

The following "forecaster hints" are adapted from Brody and Nestor, 1980:

* Correct placement of fronts is very difficult in the western Mediterranean basin due both to the lack of ship reports and to terrain effects. These problems are accentuated during the summer when fronts are weakest. The worst locations in this respect are Spain and the Balearic Islands. Forecasters should be aware of the lee trough which develops along the east coast of Spain during periods of northwesterly

flow. There is a tendency to designate this trough as frontal, instead of correctly moving the front eastward, out of the region.

* Surface cyclones generally weaken while traversing Spain, then deepen rapidly when they reach the east coast of Spain.

* The strong northwesterlies resulting from passage of an upper level trough (see 3.5.3) will occur at Zaragoza (08161) three to six hours before occurring along Spain's east coast.

3.8 Protective and Mitigating Measures

Local maritime personnel have indicated that protective measures are needed only on rare occasions. The harbor areas are well protected and ships at berth may have to double lines on the infrequent occurrence of hazardous waves within the harbors. In the event of a strong Levante, ships at anchor may have to sortie to the open sea rather than try to stay anchored on station. Again, this would be a rare occurrence.

The most likely operation to be interrupted is boating. In a strong wind event (or with swell from either a Mistral or Levante), boating from the anchorage to the harbor may be hazardous. The Mistral swell, the Levante wind and/or the Levante swell may postpone boating for periods of a day or two. Any of the other wind regimes will usually cause only a few hours delay.

3.9 Summary of Problems and Actions

Table 3-1 is intended to provide easy-to-use seasonal references for meteorologists on ships using the port of Valencia. Table 2-1 (Section 2) summarizes Table 3-1 and is intended primarily for use by ship captains.

Table 3-1. Potential problem situations at the Port of Valencia, Spain - ALL SEASONS

VESSEL LOCATION/SITUATION	POTENTIAL HAZARD	EFFECT - PRECAUTIONARY/EVASIVE ACTIONS	ADVANCE INDICATORS AND OTHER INFORMATION ABOUT POTENTIAL HAZARD
1. Moored-inner harbor. Occurs year-round; strongest in winter and spring.	a. E'ly/NE'ly winds/waves - Levante Cause minimal effects in the harbor. Caused by Azores High extending into Spain or from a low pressure system to the south of the Balearic Islands. In the cool season, usually accompanied by low clouds and rain. E'ly to SE'ly Levante will often precede cold fronts in winter/early spring.	a. Wind sensitive operations and ships with large sail area will, on occasion, be affected in the harbor. Extra mooring lines may be needed in an intense Levante episode. On rare occasions, ships berthed near the harbor entrance may feel some motion due to waves from a southeast Levante associated with a cold frontal passage. In winter, wind chill can be a factor.	a. The Levante can occur with several different weather patterns but in the most typical situation, it occurs when the Azores High extends northeastward over Spain and southern France. Also, the Levante will precede the arrival of a cold front during the cool season. In this case, a lee trough forms in the region of the Balearic Islands. At times, an intense low will form south of the Balearics and gale force (30+ kt) can be expected along the east coast of Spain. A low NE or ENE swell may be observed 12 hours prior to the Levante wind onset. Note, however, that this swell may be due to a Mistral in the Gulf of Lion and may not be associated with a Levante.
Occurs year-round; strongest in winter and spring.	b. SW'ly to W'ly winds - Vendaval Precede cold fronts and are most likely to occur in the cool season with gale force intensity (30+ kt). Precipitation usually accompanies the Vendaval/cold front system but can be delayed by as much as 12 hours after Vendaval wind onset.	b. Wind sensitive operations may be affected in the inner harbor. Also, vessels berthed near the south-facing harbor entrance may experience some motion due to waves coming into the harbor. This usually occurs with a more southerly rather than southwesterly Vendaval and is usually short-lived. Ships with a large sail area may have to double lines during a rare, intense Vendaval.	b. The most intense and frequent Vendaval winds are associated with cold fronts; however, strong southwesterly to westerly winds can occur at Valencia when a high, centered south of the Azores intensifies, resulting in a steep gradient between the high and migratory lows approaching the British Isles. During these events, maximum winds at Valencia will occur in late morning (0900L-noon) and again near 1400L. Any cold front approaching Spain's east coast from the west has the potential to cause strong Vendaval winds. Note that fronts will weaken as they approach the coast but will intensify once reaching the coast.
Occurs year-round; strongest and most frequent in winter and spring.	c. NW'ly winds - Poniente Those which follow cold fronts in the cool season are the most frequent of the Ponientes. They can occur in other seasons and can last for days in the Valencia area, averaging 15 kt with peaks to 30 kt. During an intense, widespread outbreak, winds along Spain's east coast out to 50 n mi will be relatively light, except in the Valencia area, due to the low terrain. East of the 50 n mi zone, winds will be gale force (30+ kt).	c. Only wind sensitive operations will be affected for ships in the harbor. Vessels with large sail areas may need to double lines during an intense Poniente episode. Wind chill may be a factor in winter.	c. The Poniente is a northwesterly wind behind the cold front and usually occurs in the cool season; however, northwest winds often occur in other seasons when high pressure builds from the Atlantic. Consequently, the Poniente can be expected year-round with peak frequency and peak intensity during the cool season. Any cold front is likely to be followed by a Poniente. On occasion, a high pressure center will stagnate over western Europe during the winter and northwesterlies will last for days in the Valencia area. During these episodes, winds will average 15 kt with peaks to 30 kt. Strong and gusty northwesterlies can also occur along the coast of Spain between Barcelona and Valencia following the passage of an upper level trough. These northwesterlies will occur at Zaragoza (08161) three to six hours before occurring along the east coast. Forecasters should be aware of the lee trough that forms along the coast during an outbreak of northwesterlies; there is a tendency to designate this trough as frontal, instead of correctly moving the front eastward, out of the region.
Occurs in winter and spring.	d. NE'ly winds/waves - Mistral Swell from an event in the Gulf of Lion can extend as far south as Valencia. Mistral winds of 25+ kt can occur one or two times per year. More often (4-5 times per year), swell with or without the wind will occur. This swell is a long period (15 sec) and is usually less than 10 ft.	d. Local mariners indicate that protective measures are rarely necessary for ships in the harbor. Wind chill may be a factor in winter.	d. A strong Mistral event (40+ kt) in the Gulf of Lion will normally produce some swell in the Valencia area. (See Severe Weather Guide for Marseille or Toulon for details.)

Table 3-1. (Continued)

VESSEL LOCATION/SITUATION	POTENTIAL HAZARD	EFFECT - PRECAUTIONARY/EVASIVE ACTIONS	ADVANCE INDICATORS AND OTHER INFORMATION ABOUT POTENTIAL HAZARD
2. Outer anchorage. Occurs year-round; strongest in winter and spring.	a. E'ly/NE'ly winds/waves - Levante Cause minimal effects in the harbor. Caused by Azores High extending into Spain or from a low pressure system to the south of the Balearic Islands. In the cool season, usually accompanied by low clouds and rain. E'ly to SE'ly Levante will often precede cold fronts in winter/early spring.	a. High winds and waves at the outer anchorage may force ships to sortie to the open sea. Due to the long fetch from the ENE, 12 to 14 ft swell is possible even with local winds of only 25 kt. During stagnant pressure patterns, 25 to 35 kt winds with occasional rainshowers can last for three or four days. Wind chill can be a factor in winter.	a. The Levante can occur with several different weather patterns but in the most typical situation, it occurs when the Azores High extends northeastward over Spain and southern France. Also, the Levante will precede the arrival of a cold front during the cool season. In this case, a lee trough forms in the region of the Balearic Islands. At times, an intense low will form south of the Balearics and gale force (30+ kt) can be expected along the east coast of Spain. A low NE or ENE swell may be observed 12 hours prior to the Levante wind onset. Note, however, that this swell may be due to a Mistral in the Gulf of Lion and may not be associated with a Levante.
Occurs year-round; strongest in winter and spring.	b. SW'ly to W'ly winds - Vendaval Precede cold fronts and are most likely to occur in the cool season with gale force intensity (30+ kt). Precipitation usually accompanies the Vendaval/cold front system but can be delayed by as much as 12 hrs after Vendaval wind onset.	b. In rare cases, high winds and waves at the outer anchorage may force ships to sortie to the open sea. Intense Vendaval episodes are usually of short duration (3-6 hours) and waves do not build to great heights. A more southerly Vendaval direction will bring higher waves to the outer anchorage than will southwest or westerly Vendavals due to fetch distances.	b. The most intense and frequent Vendaval winds are associated with cold fronts; however, strong southwesterly to westerly winds can occur at Valencia when a high, centered south of the Azores intensifies, resulting in a steep gradient between the high and migratory lows approaching the British Isles. During these events, maximum winds at Valencia will occur in late morning (0900L-noon) and again near 1400L. Any cold front approaching Spain's east coast from the west has the potential to cause strong Vendaval winds. Note that fronts will weaken as they approach the coast but will intensify once reaching the coast.
Occurs year-round; strongest and most frequent in winter and spring.	c. NW'ly winds - Poniente Those which follow cold fronts in the cool season are the most frequent of the Ponientes. They can occur in other seasons and can last for days in the Valencia area, averaging 15 kt with peaks to 30 kt. During an intense, widespread outbreak, winds along Spain's east coast out to 50 n mi will be relatively light, except in the Valencia area, due to the low terrain. East of the 50 n mi zone, winds will be gale force (30+ kt).	c. Wind sensitive operations will be hindered for ships at the anchorage. Waves at the anchorage are minimal due to fetch limitations. Moving to a near-shore point either south or north of Valencia will further minimize waves and winds. Wind chill can be a factor in winter.	c. The Poniente is a northwesterly wind behind the cold front and usually occurs in the cool season; however, northwest winds often occur in other seasons when high pressure builds from the Atlantic. Consequently, the Poniente can be expected year-round with peak frequency and peak intensity during the cool season. Any cold front is likely to be followed by a Poniente. On occasion, a high pressure center will stagnate over western Europe during the winter and northwesterlies will last for days in the Valencia area. During these episodes, winds will average 15 kt with peaks to 30 kt. Strong and gusty northwesterlies can also occur along the coast of Spain between Barcelona and Valencia following the passage of an upper level trough. These northwesterlies will occur at Zaragoza (08161) three to six hours before occurring along the east coast. Forecasters should be aware of the lee trough that forms along the coast during an outbreak of northwesterlies; there is a tendency to designate this trough as frontal, instead of correctly moving the front eastward, out of the region.
Occurs in winter and spring.	d. NE'ly winds/waves - Mistral Swell from an event in the Gulf of Lion can extend as far south as Valencia. Mistral winds of 25+ kt can occur one or two times per year. More often (4-5 times per year), swell with or without the wind will occur. This swell is a long period (15 sec) and is usually less than 10 ft.	d. High swell will likely be more of a problem than will high winds. During the Mistral, waves and winds will be from the same direction (northeast) but long period swell (15 sec) may cause excessive motion on ships with critical response amplitudes. Moving to a position south of the Balearics will give better protection during a Mistral event. Wind chill can be a factor in winter.	d. A strong Mistral event (40+ kt) in the Gulf of Lion will normally produce some swell in the Valencia area. (See Severe Weather Guide for Marseille or Toulon for details.)

Table 3-1. (Continued)

VESSEL LOCATION/SITUATION	POTENTIAL HAZARD	EFFECT - PRECAUTIONARY/EVASIVE ACTIONS	ADVANCE INDICATORS AND OTHER INFORMATION ABOUT POTENTIAL HAZARD
3. Arriving/departing. Occurs year-round; strongest in winter and spring.	a. E'ly/NE'ly winds/waves - Levante Cause minimal effects in the harbor. Caused by Azores High extending into Spain or from a low pressure system to the south of the Balearic Islands. In the cool season, usually accompanied by low clouds and rain. E'ly to SE'ly Levante will often precede cold fronts in winter/early spring.	a. Caution must be used on departure. The harbor area is protected from high waves but after passing south of the breakwater, wave heights increase dramatically. Highest waves will most likely be from the ENE and heading into them will minimize ship's roll. In an intense Levante, maneuvering in the inner harbor area may be difficult, especially for ships with large sail area. Wind chill can be a factor in winter.	a. The Levante can occur with several different weather patterns but in the most typical situation, it occurs when the Azores High extends northeastward over Spain and southern France. Also, the Levante will precede the arrival of a cold front during the cool season. In this case, a lee trough forms in the region of the Balearic Islands. At times, an intense low will form south of the Balearics and gale force (30+ kt) can be expected along the east coast of Spain. A low NE or ENE swell may be observed 12 hours prior to the Levante wind onset. Note, however, that this swell may be due to a Mistral in the Gulf of Lion and may not be associated with a Levante.
Occurs year-round; strongest in winter and spring.	b. SW'ly to W'ly winds - Vendaval Precede cold fronts and are most likely to occur in the cool season with gale force intensity (30+ kt). Precipitation usually accompanies the Vendaval/cold front system but can be delayed by as much as 12 hours after Vendaval wind onset.	b. If the Vendaval is southerly, waves will be felt while still inside the breakwater and wave heights will increase sharply outside the breakwater. If the Vendaval is southwest or west, waves will be at a minimum but winds will affect those vessels with large sail area. In an intense Vendaval event, maneuvering in the inner harbor areas may be hindered.	b. The most intense and frequent Vendaval winds are associated with cold fronts; however, strong southwesterly to westerly winds can occur at Valencia when a high, centered south of the Azores intensifies, resulting in a steep gradient between the high and migratory lows approaching the British Isles. During these events, maximum winds at Valencia will occur in late morning (0900L-noon) and again near 1400L. Any cold front approaching Spain's east coast from the west has the potential to cause strong Vendaval winds. Note that fronts will weaken as they approach the coast but will intensify once reaching the coast.
Occurs year-round; strongest and most frequent in winter and spring.	c. NW'ly winds - Poniente Those which follow cold fronts in the cool season are the most frequent of the Ponientes. They can occur in other seasons and can last for days in the Valencia area, averaging 15 kt with peaks to 30 kt. During an intense, widespread outbreak, winds along Spain's east coast out to 50 n mi will be relatively light, except in the Valencia area, due to the low terrain. East of the 50 n mi zone, winds will be gale force (30+ kt).	c. Winds north and south of Valencia may be less intense than at Valencia due to the low terrain of the area. An area from the coast to 50 n mi offshore will have light winds except near Valencia. Winds east of the 50 n mi zone will also be strong. Because of fetch limitations, waves do not usually build to large heights near the harbor entrance; however, maneuvering in the inner harbor areas may be hindered, especially for ships with large sail area. Wind chill may be a factor in winter.	c. The Poniente is a northwesterly wind behind the cold front and usually occurs in the cool season; however, northwest winds often occur in other seasons when high pressure builds from the Atlantic. Consequently, the Poniente can be expected year-round with peak frequency and peak intensity during the cool season. Any cold front is likely to be followed by a Poniente. On occasion, a high pressure center will stagnate over western Europe during the winter and northwesterlies will last for days in the Valencia area. During these episodes, winds will average 15 kt with peaks to 30 kt. Strong and gusty northwesterlies can also occur along the coast of Spain between Barcelona and Valencia following the passage of an upper level trough. These northwesterlies will occur at Zaragoza (08161) three to six hours before occurring along the east coast. Forecasters should be aware of the lee trough that forms along the coast during an outbreak of northwesterlies; there is a tendency to designate this trough as frontal, instead of correctly moving the front eastward, out of the region.
Occurs in winter and spring.	d. NE'ly winds/waves - Mistral Swell from an event in the Gulf of Lion can extend as far south as Valencia. Mistral winds of 25+ kt can occur one or two times per year. More often (4-5 times per year), swell with or without the wind will occur. This swell is a long period (15 sec) and is usually less than 10 ft.	d. Winds are usually not strong at Valencia during a Mistral; however, waves outside the harbor can be hazardous. Use caution on departure as wave heights increase sharply just outside the breakwater. A northerly or southerly heading after departure will minimize the swell effect while an easterly heading will put the swell on the beam. Wind chill can be a factor in winter.	d. A strong Mistral event (40+ kt) in the Gulf of Lion will normally produce some swell in the Valencia area. (See Severe Weather Guide for Marseille or Toulon for details.)
Occurs daily end of spring to early fall.	e. Sea breeze - SE'ly Onset about 1400; lasts until dusk. Speed 10 to 20 kt. Raises three to five ft; wind waves at outer anchorage.	e. Causes problems for large sail area ships entering/leaving harbor during period of 1500-1900L. Schedule movements earlier. Local chop hazardous to small boat operations to outer anchorage late afternoon/evening.	e. Occurs daily, 1400L to dusk, beginning end of spring through early fall.

Table 3-1. (Continued)

VESSEL LOCATION/SITUATION	POTENTIAL HAZARD	EFFECT - PRECAUTIONARY/EVASIVE ACTIONS	ADVANCE INDICATORS AND OTHER INFORMATION ABOUT POTENTIAL HAZARD
4. Small boats. Occurs year-round; strongest in winter and spring.	a. E'ly/NE'ly wind/waves - Levante Cause minimal effects in the harbor. Caused by Azores High extending into Spain or from a low pressure system to the south of the Balearic Islands. In the cool season, usually accompanied by low clouds and rain. E'ly to SE'ly Levante will often precede cold fronts in winter/early spring.	a. Inner harbor operations will be minimally affected. Runs to/from the outer anchorage may be curtailed due to hazardous winds/waves at the anchorage. Winds can change direction quickly, especially in winter, causing waves to cross at dangerous angles to the winds and create hazardous conditions for small boats. Wind chill can be a factor in winter.	a. The Levante can occur with several different weather patterns but in the most typical situation, it occurs when the Azores High extends northeastward over Spain and southern France. Also, the Levante will precede the arrival of a cold front during the cool season. In this case, a lee trough forms in the region of the Balearic Islands. At times, an intense low will form south of the Balearics and gale force (30+ kt) can be expected along the east coast of Spain. A low NE or ENE swell may be observed 12 hours prior to the Levante wind onset. Note, however, that this swell may be due to a Mistral in the Gulf of Lion and may not be associated with a Levante.
Occurs year-round; strongest in winter and spring.	b. SW'ly to W'ly winds - Vendaval Precede cold fronts and are most likely to occur in the cool season with gale force intensity (30+ kt). Precipitation usually accompanies the Vendaval/cold front system but can be delayed by as much as 12 hours after Vendaval wind onset.	b. Inner harbor operations will be minimally affected. Runs to/from the outer anchorage may be curtailed due to hazardous winds/waves at the anchorage. If Vendaval is southerly, boat runs to/from the ships anchored in the outer basin (still inside the harbor) may be affected as some waves may penetrate the south-facing harbor entrance. Winds can change direction quickly, especially in winter, causing waves to cross at dangerous angles to the winds and create hazardous conditions for small boats.	b. The most intense and frequent Vendaval winds are associated with cold fronts; however, strong southwesterly to westerly winds can occur at Valencia when a high, centered south of the Azores intensifies, resulting in a steep gradient between the high and migratory lows approaching the British Isles. During these events, maximum winds at Valencia will occur in late morning (0900L-noon) and again near 1400L. Any cold front approaching Spain's east coast from the west has the potential to cause strong Vendaval winds. Note that fronts will weaken as they approach the coast but will intensify once reaching the coast.
Occurs year-round; strongest and most frequent in winter and spring.	c. NW'ly winds - Poniente Those which follow cold fronts in the cool season are the most frequent of the Ponientes. They can occur in other seasons and can last for days in the Valencia area, averaging 15 kt with peaks to 30 kt. During an intense, widespread outbreak, winds along Spain's east coast out to 50 n mi will be relatively light, except in the Valencia area, due to the low terrain. East of the 50 n mi zone, winds will be gale force (30+ kt).	c. Inner harbor operations will be minimally affected. Runs to/from the outer anchorage may be curtailed due to hazardous winds/waves at the anchorage. Winds can change direction quickly, especially in winter, causing waves to cross at dangerous angles to the winds and create hazardous conditions for small boats. Wind chill can be a factor in winter.	c. The Poniente is a northwesterly wind behind the cold front and usually occurs in the cool season; however, northwest winds often occur in other seasons when high pressure builds from the Atlantic. Consequently, the Poniente can be expected year-round with peak frequency and peak intensity during the cool season. Any cold front is likely to be followed by a Poniente. On occasion, a high pressure center will stagnate over western Europe during the winter and northwesterlies will last for days in the Valencia area. During these episodes, winds will average 15 kt with peaks to 30 kt. Strong and gusty northwesterlies can also occur along the coast of Spain between Barcelona and Valencia following the passage of an upper level trough. These northwesterlies will occur at Zaragoza (08161) three to six hours before occurring along the east coast. Forecasters should be aware of the lee trough that forms along the coast during an outbreak of northwesterlies; there is a tendency to designate this trough as frontal, instead of correctly moving the front eastward, out of the region.
Occurs in winter and spring.	d. NE'ly winds/waves - Mistral Swell from an event in the Gulf of Lion can extend as far south as Valencia. Mistral winds of 25+ kt can occur one or two times per year. More often (4-5 times per year), swell with or without the wind will occur. This swell is a long period (15 sec) and is usually less than 10 ft.	d. Inner harbor operations will be minimally affected. Runs to/from the outer anchorage may be curtailed due to hazardous winds/waves at the anchorage. Winds can change direction quickly, especially in winter, causing waves to cross at dangerous angles to the winds and create hazardous conditions for small boats. Wind chill can be a factor in winter.	d. A strong Mistral event (40+ kt) in the Gulf of Lion will normally produce some swell in the Valencia area. (See Severe Weather Guide for Marseille or Toulon for details.)

REFERENCES

Brody, L.R. and M.J.R. Nestor, 1980: Regional Forecasting Aids for the Mediterranean Basin, NAVENVPREDRSCHFAC Technical Report TR 80-10. Naval Environmental Prediction Research Facility, Monterey, California 93941.

FICEURLANT, 1987: Port Directory for Valencia (1985), Spain. Fleet Intelligence Center Europe and Atlantic, Norfolk, Virginia.

Naval Weather Service, 1975: A Climatic Resume of the Mediterranean Sea. Naval Weather Service Command, Asheville, North Carolina.

Port Visit Information

MAY 1987. NEPRF meteorologists D. Perryman and R. Miller met with the Chief Pilot to obtain much of the information included in this port evaluation.

APPENDIX A

General Purpose Oceanographic Information

This section provides general information on wave forecasting and wave climatology as used in this study. The forecasting material is not harbor specific. The material in paragraphs A.1 and A.2 was extracted from H.O. Pub. No. 603, Practical Methods for Observing and Forecasting Ocean Waves (Pierson, Neumann, and James, 1955). The information on fully arisen wave conditions (A.3) and wave conditions within the fetch region (A.4) is based on the JONSWAP model. This model was developed from measurements of wind wave growth over the North Sea in 1973. The JONSWAP model is considered more appropriate for an enclosed sea where residual wave activity is minimal and the onset and end of locally forced wind events occur rapidly (Thornton, 1986), and where waves are fetch limited and growing (Hasselmann, et al., 1976). Enclosed sea, rapid onset/subsiding local winds, and fetch limited waves are more representative of the Mediterranean waves and winds than the conditions of the North Atlantic from which data was used for the Pierson and Moskowitz (P-M) Spectra (Neumann and Pierson 1966). The P-M model refined the original spectra of H.O. 603, which over developed wave heights.

The primary difference in the results of the JONSWAP and P-M models is that it takes the JONSWAP model longer to reach a given height or fully developed seas. In part this reflects the different starting wave conditions. Because the propagation of waves from surrounding areas into semi-enclosed seas, bays, harbors, etc. is limited, there is little residual wave action following periods of locally light/calm winds and

the sea surface is nearly flat. A local wind developed wave growth is therefore slower than wave growth in the open ocean where some residual wave action is generally always present. This slower wave development is a built in bias in the formulation of the JONSWAP model which is based on data collected in an enclosed sea.

A.1 Definitions

Waves that are being generated by local winds are called "SEA". Waves that have traveled out of the generating area are known as "SWELL". Seas are chaotic in period, height and direction while swell approaches a simple sine wave pattern as its distance from the generating area increases. An in-between state exists for a few hundred miles outside the generating area and is a condition that reflects parts of both of the above definitions. In the Mediterranean area, because its fetches and open sea expanses are limited, SEA or IN-BETWEEN conditions will prevail. The "SIGNIFICANT WAVE HEIGHT" is defined as the average value of the heights of the one-third highest waves. PERIOD and WAVE LENGTH refer to the time between passage of, and distances between, two successive crests on the sea surface. The FREQUENCY is the reciprocal of the period ($f = 1/T$) therefore as the period increases the frequency decreases. Waves result from the transfer of energy from the wind to the sea surface. The area over which the wind blows is known as the FETCH, and the length of time that the wind has blown is the DURATION. The characteristics of waves (height, length, and period) depend on the duration, fetch, and velocity of the wind. There is a continuous generation of small short waves from the time the wind starts until it stops. With continual transfer of energy from the wind to the sea

surface the waves grow with the older waves leading the growth and spreading the energy over a greater range of frequencies. Throughout the growth cycle a SPECTRUM of ocean waves is being developed.

A.2 Wave Spectrum

Wave characteristics are best described by means of their range of frequencies and directions or their spectrum and the shape of the spectrum. If the spectrum of the waves covers a wide range of frequencies and directions (known as short-crested conditions), SEA conditions prevail. If the spectrum covers a narrow range of frequencies and directions (long crested conditions), SWELL conditions prevail. The wave spectrum depends on the duration of the wind, length of the fetch, and on the wind velocity. At a given wind speed and given state of wave development, each spectrum has a band of frequencies where most of the total energy is concentrated. As the wind speed increases the range of significant frequencies extends more and more toward lower frequencies (longer periods). The frequency of maximum energy is given in equation 1.1 where v is the wind speed in knots.

$$f_{max} = \frac{2.476}{v} \qquad (1.1)$$

The wave energy, being a function of height squared, increases rapidly as the wind speed increases and the maximum energy band shifts to lower frequencies. This results in the new developing smaller waves (higher frequencies) becoming less significant in the energy spectrum as well as to the observer. As larger waves develop an observer will pay less and less attention to the small waves. At the low frequency (high period) end

the energy drops off rapidly, the longest waves are relatively low and extremely flat, and therefore also masked by the high energy frequencies. The result is that 5% of the upper frequencies and 3% of the lower frequencies can be cut-off and only the remaining frequencies are considered as the "significant part of the wave spectrum". The resulting range of significant frequencies or periods are used in defining a fully arisen sea. For a fully arisen sea the approximate average period for a given wind speed can be determined from equation (1.2).

$$\bar{T} = 0.285v \qquad (1.2)$$

Where v is wind speed in knots and $\bar{T}$ is period in seconds. The approximate average wave length in a fully arisen sea is given by equation (1.3).

$$\bar{L} = 3.41\ \bar{T}^2 \qquad (1.3)$$

Where $\bar{L}$ is average wave length in feet and $\bar{T}$ is average period in seconds.

The approximate average wave length of a fully arisen sea can also be expressed as:

$$\bar{L} = .67\text{"L"} \qquad (1.4)$$

where "L" = $5.12T^2$, the wave length for the classic sine wave.

A.3 Fully Arisen Sea Conditions

For each wind speed there are minimum fetch (n mi) and duration (hr) values required for a fully arisen sea to exist. Table A-1 lists minimum fetch and duration values for selected wind speeds, values of significant wave (average of the highest 1/3 waves)

period and height, and wave length of the average wave during developing and fully arisen seas. The minimum duration time assumes a start from a flat sea. When pre-existing lower waves exist the time to fetch limited height will be shorter. Therefore the table duration time represents the maximum duration required.

Table A-1. Fully Arisen Deep Water Sea Conditions Based on the JONSWAP Model.

Wind Speed (kt)	Minimum Fetch/Duration (n mi) (hrs)	Sig Wave (H1/3 Period/Height (sec) (ft)	Wave Length (ft)[1,2] Developing/Fully /Arisen L X (.5) /L X (.67)
10	28 / 4	4 / 2	41 / 55
15	55 / 6	6 / 4	92 / 123
20	110 / 8	8 / 8	164 / 220
25	160 / 11	9 / 12	208 / 278
30	210 / 13	11 / 16	310 / 415
35	310 / 15	13 / 22	433 / 580
40	410 / 17	15 / 30	576 / 772

NOTES:

[1] Depth throughout fetch and travel zone must be greater than 1/2 the wave length, otherwise shoaling and refraction take place and the deep water characteristics of waves are modified.

[2] For the classic sine wave the wave length (L) equals 5.12 times the period (T) squared ($L = 5.12T^2$). As waves develop and mature to fully developed waves and then propagate out of the fetch area as swell there wave lengths approach the classic sine wave length. Therefore the wave lengths of developing waves are less than those of fully developed waves which in turn are less than the length of the resulting swell. The factor of .5 (developing) and .67 (fully developed) reflect this relationship.

A.4 Wave Conditions Within The Fetch Region

Waves produced by local winds are referred to as SEA. In harbors the local sea or wind waves may create hazardous conditions for certain operations. Generally within harbors the fetch lengths will be short and therefore the growth of local wind waves will be fetch limited. This implies that there are locally determined upper limits of wave height and period for each wind velocity. Significant changes in speed or direction will result in generation of a new wave group with a new set of height and period limits. Once a fetch limited sea reaches its upper limits no further growth will occur unless the wind speed increases.

Table A-2 provides upper limits of period and height for given wind speeds over some selected fetch lengths. The duration in hours required to reach these upper limits (assuming a start from calm and flat sea conditions) is also provided for each combination of fetch length and wind speed. Some possible uses of Table A-2 information are:

1) If the only waves in the area are locally generated wind waves, the Table can be used to forecast the upper limit of sea conditions for combinations of given wind speeds and fetch length.

2) If deep water swell is influencing the local area in addition to locally generated wind waves, then the Table can be used to determine the wind waves that will combine with the swell. Shallow water swell conditions are influenced by local bathymetry (refraction and shoaling) and will be addressed in each specific harbor study.

3) Given a wind speed over a known fetch length the maximum significant wave conditions and time needed to reach this condition can be determined.

Table A-2. Fetch Limited Wind Wave Conditions and Time Required to Reach These Limits (Based on JONSWAP Model). Enter the table with wind speed and fetch length to determine the significant wave height and period, and time duration needed for wind waves to reach these limiting factors. All of the fetch/speed combinations are fetch limited except the 100 n mi fetch and 18 kt speed.

Format: height (feet)/period (seconds)
duration required (hours)

Fetch Length (n mi) \ Wind Speed (kt)	18	24	30	36	42
10	2/3-4 1-2	3/3-4 2	3-4/4 2	4/4-5 1-2	5/5 1-2
20	3/4-5 2-3	4/4-5 3	5/5 3	6/5-6 3-4	7/5-6 3
30	3-4/5 3	5/5-6 4	6/6 3-4	7/6 3-4	8/6-7 3
40	4-5/5-6 4-5	5/6 4	6-7/6-7 4	8/7 4	9-10/7-8 3-4
100	5/6-7[1] 5-6	9/8 8	11/9 7	13/9 7	15-16/9-10 7

[1] 18 kt winds are not fetch limited over a 100 n mi fetch.

An example of expected wave conditions based on Table A-2 follows:

WIND FORECAST OR CONDITION

An offshore wind of about 24 kt with a fetch limit of 20 n mi (ship is 20 n mi from the coast) is forecast or has been occurring.

SEA FORECAST OR CONDITION

From Table A-2: If the wind condition is forecast to last, or has been occurring, for at least 3 hours:

Expect sea conditions of 4 feet at 4-5 second period to develop or exist. If the condition lasts less than 3 hours the seas will be lower. If the condition lasts beyond 3 hours the sea will not grow beyond that developed at the end of about 3 hours unless there is an increase in

wind speed or a change in the direction that results in a longer fetch.

A.5 Wave Climatology

The wave climatology used in these harbor studies is based on 11 years of Mediterranean SOWM output. The MED-SOWM is discussed in Volume II of the U.S. Naval Oceanography Command Numerical Environmental Products Manual (1986). A deep water MED-SOWM grid point was selected as representative of the deep water wave conditions outside each harbor. The deep water waves were then propagated into the shallow water areas. Using linear wave theory and wave refraction computations the shallow water climatology was derived from the modified deep water wave conditions. This climatology does not include the local wind generated seas. This omission, by design, is accounted for by removing all wave data for periods less than 6 seconds in the climatology. These shorter period waves are typically dominated by locally generated wind waves.

A.6 Propagation of Deep Water Swell Into Shallow Water Areas

When deep water swell moves into shallow water the wave patterns are modified, i.e., the wave heights and directions typically change, but the wave period remains constant. Several changes may take place including shoaling as the wave feels the ocean bottom, refraction as the wave crest adjusts to the bathymetry pattern, changing so that the crest becomes more parallel to the bathymetry contours, friction with the bottom sediments, interaction with currents, and adjustments caused by water temperature gradients. In this work, only shoaling and refraction effects are

considered. Consideration of the other factors are beyond the resources available for this study and, furthermore, they are considered less significant in the harbors of this study than the refraction and shoaling factors.

To determine the conditions of the deep water waves in the shallow water areas the deep water conditions were first obtained from the Navy's operational MED-SOWM wave model. The bathymetry for the harbor/area of interest was extracted from available charts and digitized for computer use. Figure A-1 is a sample plot of bathymetry as used in this project. A ray path refraction/shoaling program was run for selected combinations of deep water wave direction and period. The selection was based on the near deep water wave climatology and harbor exposure. Each study area requires a number of ray path computations. Typically there are 3 or 4 directions (at 30° increments) and 5 or 6 periods (at 2 second intervals) of concern for each area of study. This results in 15 to 24 plots per area/harbor. To reduce this to a manageable format for quick reference, specific locations within each study area were selected and the information was summarized and is presented in the specific harbor studies in tabular form.

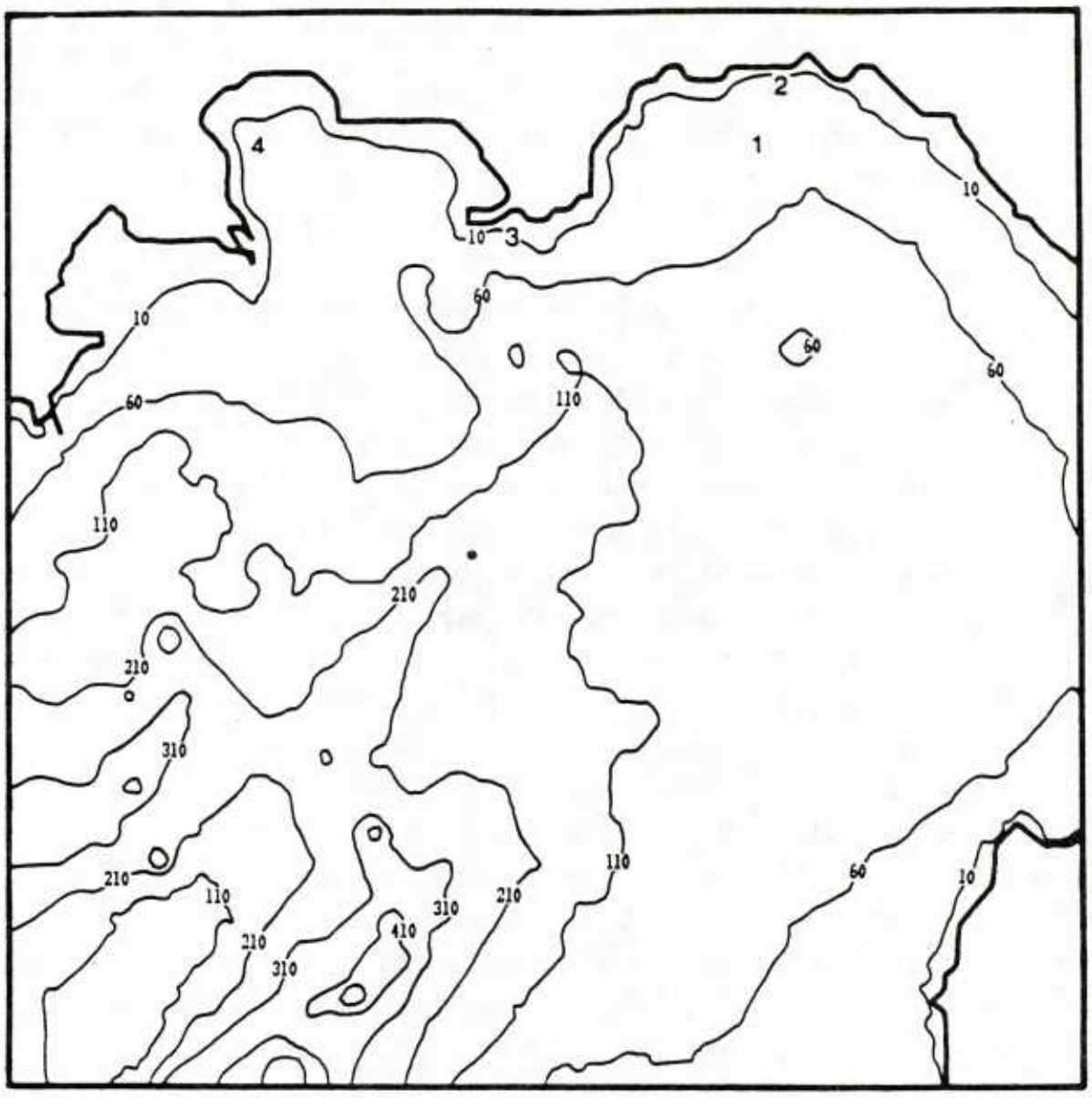


Figure A-1. Example plot of bathymetry (Naples harbor) as used in this project. For plotting purposes only, contours are at 50 fathom intervals from an initial 10 fathom contour. The larger size numbers identify specific anchorage areas addressed in the harbor study.

REFERENCES

Hasselmann, K. D., D. B. Ross, P. Muller, and W. Sell, 1976: A parametric wave prediction model. J. Physical Oceanography, Vol. 6, pp. 208-228.

Neumann, G., and W. J. Pierson Jr., 1966: Principles of Physical Oceanography. Prentice-Hall, Englewood Cliffs.

Pierson, W.J. Jr., G. Neumann, and R. W. James, 1955: Practical Methods for Observing and Forecasting Ocean Waves, H.O. Pub. No. 603.

Thornton, E. B., 1986: Unpublished lecture notes for OC 3610, Waves and Surf Forecasting. Naval Postgraduate School, Monterey CA.

U. S. Naval Oceanography Command, 1986: Vol. II of the U.S. Naval Oceanography Command Numerical Environmental Products Manual.

DISTRIBUTION LIST

SNDL

21A1	CINCLANTFLT
21A3	CINCUSNAVEUR
22A1	COMSECONDFLT
22A3	COMSIXTHFLT
23B3	Special Force Commander EUR
24A1	Naval Air Force Commander LANT
24D1	Surface Force Commander LANT
24E	Mine Warfare Command
24G1	Submarine Force Commander LANT
26QQ1	Special Warfare Group LANT
28A1	Carrier Group LANT (2)
28B1	Cruiser-Destroyer Group LANT (2)
28D1	Destroyer Squadron LANT (2)
28J1	Service Group and Squadron LANT (2)
28K1	Submarine Group and Squadron LANT
28L1	Amphibious Squadron LANT (2)
29A1	Guided Missile Cruiser LANT
29B1	Aircraft Carrier LANT
29D1	Destroyer LANT (DD 931/945 Class)
29E1	Destroyer LANT (DD 963 Class)
29F1	Guided Missile Destroyer LANT
29G1	Guided Missile Frigate (LANT)
29I1	Frigate LANT (FF 1098)
29J1	Frigate LANT (FF 1040/1051 Class)
29K1	Frigate LANT (FF 1052/1077 Class)
29L1	Frigate LANT (FF 1078/1097 Class)
29N1	Submarine LANT (SSN)
29Q	Submarine LANT SSBN
29R1	Battleship Lant (2)
29AA1	Guided Missile Frigate LANT (FFG 7)
29BB1	Guided Missile Destroyer (DDG 993)
31A1	Amphibious Command Ship LANT (2)
31B1	Amphibious Cargo Ship LANT
31G1	Amphibious Transport Ship LANT
31H1	Amphibious Assault Ship LANT (2)
31I1	Dock Landing Ship LANT
31J1	Dock Landing Ship LANT
31M1	Tank Landing Ship LANT
32A1	Destroyer Tender LANT
32C1	Ammunition Ship LANT
32G1	Combat Store Ship LANT
32H1	Fast Combat Support Ship LANT
32N1	Oiler LANT
32Q1	Replenishment Oiler LANT
32S1	Repair Ship LANT
32X1	Salvage Ship LANT
32DD1	Submarine Tender LANT
32EE1	Submarine Rescue Ship LANT
32KK	Miscellaneous Command Ship
32QQ1	Salvage and Rescue Ship LANT
32TT	Auxiliary Aircraft Landing Training Ship

42N1	Air Anti-Submarine Squadron VS LANT
42P1	Patrol Wing and Squadron LANT
42BB1	Helicopter Anti-Submarine Squadron HS LANT
42CC1	Helicopter Anti-Submarine Squadron Light HSL LANT
C40	Monterey, Naples, Sigonella and Souda Bay only
FD2	Oceanographic Office - COMNAVOCEANCOM
FD3	Fleet Numerical Oceanography Center - FNOC
FD4	Oceanography Center - NAVEASTOCEANCEN
FD5	Oceanography Command Center - COMNAVOCEANCOM

copy to:

21A2	CINCPACFLT
22A2	Fleet Commander PAC
24F	Logistics Command
24H1	Fleet Training Command LANT
28A2	Carrier Group PAC (2)
29B2	Aircraft Carrier PAC (2)
29R2	Battleships PAC (2)
31A2	Amphibious Command Ship PAC (2)
31H2	Amphibious Assault Ship PAC (2)
FA2	Fleet Intelligence Center
FC14	Air Station NAVEUR
FD1	Oceanography Command
USDAO	France, Israel, Italy and Spain

NAVENVPREDRSCHFAC SUPPLEMENTARY DISTRIBUTION

COMMANDER IN CHIEF
U.S. CENTRAL COMMAND
MACDILL AFB, FL 33608

USCINCENT
ATTN: WEATHER DIV. (CCJ3-W)
MACDILL AFB, FL 33608-7001

ASST. FOR ENV. SCIENCES
ASST. SEC. OF THE NAVY (R&D)
ROOM 5E731, THE PENTAGON
WASHINGTON, DC 20350

CHIEF OF NAVAL RESEARCH (2)
LIBRARY SERVICES, CODE 784
BALLSTON TOWER #1
800 QUINCY ST.
ARLINGTON, VA 22217-5000

OFFICE OF NAVAL RESEARCH
CODE 1122AT, ATMOS. SCIENCES
ARLINGTON, VA 22217-5000

OFFICE OF NAVAL RESEARCH
ENV. SCI. PROGRAM, CODE 112
ARLINGTON, VA 22217-5000

OFFICE OF NAVAL RESEARCH
ATTN: PROGRAM MANAGER, 1122CS
ARLINGTON, VA 22217-5000

OFFICE OF NAVAL RESEARCH
ATTN: HEAD, OCEAN SCIENCES DIV
CODE 1122
ARLINGTON, VA 22217-5000

OFFICE OF NAVAL RESEARCH
CODE 1122 MM, MARINE METEO.
ARLINGTON, VA 22217-5000

OFFICE OF NAVAL TECHNOLOGY
ONR (CODE 22)
800 N. QUINCY ST.
ARLINGTON, VA 22217-5000

CHIEF OF NAVAL OPERATIONS
(OP-006)
U.S. NAVAL OBSERVATORY
WASHINGTON, DC 20390

CHIEF OF NAVAL OPERATIONS
NAVY DEPARTMENT, OP-986G
WASHINGTON, DC 20350

CHIEF OF NAVAL OPERATIONS
U.S. NAVAL OBSERVATORY
DR. RECHNITZER, OP-952F
34TH & MASS AVE.
WASHINGTON, DC 20390

CHIEF OF NAVAL OPERATIONS
OP-952D
U.S. NAVAL OBSERVATORY
WASHINGTON, DC 20390

CHIEF OF NAVAL OPERATIONS
NAVY DEPARTMENT, OP-953
WASHINGTON, DC 20350

COMMANDANT OF THE MARINE CORPS
HDQ. U.S. MARINE CORPS
WASHINGTON, DC 20380

OJCS/J3/ESD
THE PENTAGON, ROOM 2B887
WASHINGTON, DC 20301-5000

OFFICER IN CHARGE
NAVOCEANCOMDET
NAVAL EDUCATION & TRNG CENTER
NEWPORT, RI 02841-5000

OFFICER IN CHARGE
U.S. NAVOCEANCOMDET
APO NEW YORK 09406-5000

COMMANDING OFFICER
NAVAL RESEARCH LAB
ATTN: LIBRARY, CODE 2620
WASHINGTON, DC 20390

OFFICE OF NAVAL RESEARCH
SCRIPPS INST. OF OCEANOGRAPHY
LA JOLLA, CA 92037

COMMANDING OFFICER
NORDA
BAY ST. LOUIS
JCSC, MS 39529-5004

COMNAVOCEANCOM
ATTN: CODE N5
BAY ST. LOUIS
JCSC, MS 39529-5000

SUPERINTENDENT
LIBRARY REPORTS
U.S. NAVAL ACADEMY
ANNAPOLIS, MD 21402

CHAIRMAN
OCEANOGRAPHY DEPT.
U.S. NAVAL ACADEMY
ANNAPOLIS, MD 21402

DIRECTOR OF RESEARCH
U.S. NAVAL ACADEMY
ANNAPOLIS, MD 21402

NAVAL POSTGRADUATE SCHOOL
OCEANOGRAPHY DEPT, CODE 68
MONTEREY, CA 93943-5000

LIBRARY
NAVPGSCOL
MONTEREY, CA 93943-5002

PRESIDENT
NAVAL WAR COLLEGE
GEOPHYS. OFFICER, NAVOPS DEPT.
NEWPORT, RI 02841

COMMANDER
NAVAL SAFETY CENTER
NAVAL AIR STATION
NORFOLK, VA 23511

COMSPAWARSYSCOM
ATTN: CAPT. R. PLANTE
CODE 3213, NAVY DEPT.
WASHINTON, DC 20363-5100

COMMANDER, D.W. TAYLOR NAVAL
SHIP RSCH. & DEV. CENTER
SURFACE SHIP DYNAMICS BRANCH
ATTN: S. BALES
BETHESDA, MD 20084-5000

COMMANDER
NAVSURFWEACEN, CODE R42
DR. B. KATZ, WHITE OAKS LAB
SILVER SPRING, MD 20903-5000

DIRECTOR
NAVSURFWEACEN, WHITE OAKS
NAVY SCIENCE ASSIST, PROGRAM
SILVER SPRING, MD 20903-5000

USAFETAC/TS
SCOTT AFB, IL 62225

3350TH TECH. TRNG GROUP
TTGU/2/STOP 623
CHANUTE AFB, IL 61868

OFFICER IN CHARGE
SERVICE SCHOOL COMMAND
DET. CHANUTE/STOP 62
CHANUTE AFB, IL 61868

U.S. ARMY RESEARCH OFFICE
ATTN: GEOPHYSICS DIV.
P.O. BOX 12211
RESEARCH TRIANGLE PARK, NC
27709

COMMANDER
COASTAL ENGINEERING RSCH. CEN
KINGMAN BLDG.
FT. BELVOIR, VA 22060

DIRECTOR
LIBRARY, TECH. INFO. CEN.
ARMY ENG. WATERWAYS STATION
VICKSBURG, MS 39180

DIRECTOR
DTIC, CAMERON STATION
ALEXANDRIA, VA 22314

DIRECTOR, ENV. & LIFE SCI.
OFFICE OF UNDERSEC OF DEFENSE
FOR RSCH & ENG. E&LS
RM. 3D129, THE PENTAGON
WASHINGTON, DC 20505

CENTRAL INTELLIGENCE AGENCY
ATTN: OCR STANDARD DIST.
WASHINGTON, DC 20505

DIRECTOR, TECH. INFORMATION
DEFENSE ADV. RSCH PROJECTS
1400 WILSON BLVD.
ARLINGTON, VA 22209

DEFENSE LOGISTICS STUDIES
INFORMATION EXCHANGE
ARMY LOGISTICS MANAGE. CENTER
FT. LEE, VA 23801

CHIEF, MARINE SCI. SECTION
U.S. COAST GUARD ACADEMY
NEW LONDON, CT 06320

COMMANDING OFFICER
USCG RESTRACEN
YORKTOWN, VA 23690

COMMANDING OFFICER
USCG RSCH & DEV. CENTER
GROTON, CT 06340

NOAA
OCEANOGROAPHIC SERVS. DIV.
6010 EXECUTIVE BLVD.
ROCKVILLE, MD 20852

FEDERAL COORD. FOR METEORO.
SERVS. & SUP. RSCH. (OFCM)
11426 ROCKVILLE PIKE
SUITE 300
ROCKVILLE, MD 20852

NATIONAL CLIMATIC CENTER
ATTN: L. PRESTON D542X2
FEDERAL BLDG. - LIBRARY
ASHEVILLE, NC 28801

DIRECTOR
NATIONAL OCEANO. DATA CENTER
E/OC23, NOAA
WASHINGTON, DC 20235

NOAA RSCH FACILITIES CENTER
P.O. BOX 520197
MIAMI, FL 33152

DIRECTOR
ATLANTIC MARINE CENTER
COAST & GEODETIC SURVEY, NOAA
439 W. YORK ST.
NORFOLK, VA 23510

CHIEF, INTERNATIONAL AFFAIRS
NATIONAL WEATHER SERVICE
8060 13TH STREET
SILVER SPRING, MD 20910

HEAD
OFFICE OF OCEANO. & LIMNOLOGY
SMITHSONIAN INSTITUTION
WASHINGTON, DC 20560

SCRIPPS INSTITUTION OF
OCEANOGRAPHY LIBRARY
DOCUMENTS/REPORTS SECTION
LA JOLLA, CA 92037

SCIENCE APPLICATIONS
INTERNATIONAL CORP. (SAIC)
205 MONTECITO AVE.
MONTEREY, CA 93940

OCEANROUTES, INC.
680 W. MAUDE AVE.
SUNNYVALE, CA 94086-3518

MR W.G. SCHRAMM
WORLD METEOROLOGICAL ORG.
CASE POSTALE #5, CH-1211
GENEVA, SWITZERLAND

DIRECTOR, INSTITUTE OF
PHYSICAL OCEANOGRAPHY
HARALDSGADE 6
2200 COPENHAGEN N.
DENMARK

DIRECTOR OF NAVAL OCEANOGRAPHY
& METEOROLOGY
MINISTRY OF DEFENCE
OLD WAR OFFICE BLDG.
LONDON, S.W.1. ENGLAND

THE BRITISH LIBRARY
SCIENCE REFERENCE LIBRARY (A)
25 SOUTHAMPTON BLDGS.
CHANCERY LANE
LONDON WC2A IAW

MINISTRY OF DEFENCE
NAVY DEPARTMENT
ADMIRALTY RESEARCH LAB
TEDDINGTON, MIDDX ENGLAND

COMMANDER IN CHIEF
ATTN: STAFF METEOROLOGIST &
OCEANOGORAPHY OFFICER
NORTHWOOD, MIDDLESEX HA6 3HP
ENGLAND

LIBRARY, INSTITUTE OF
OCEANOGRAPHIC SCIENCES
ATTN: DIRECTOR
WORMLEY, GODALMING
SURRY GU8 5UB, ENGLAND

METEOROLOGIE NATIONALE
SMM/DOCUMENTATION
2, AVENUE RAPP
75340 PARIS CEDEX 07
FRANCE

SERVICE HYDROGRAPHIQUE ET
OCEANOGRAPHIQUE DE LA MARINE
ESTABLISSEMENT PRINCIPAL
RUE DU CHATELLIER, B.P. 426
29275 - BREST CEDEX, FRANCE

METEOROLOGIE NATIONALE
1 QUAI BRANLY
75, PARIS (7)
FRANCE

DIRECTION DE LA METEOROLOGIE
ATTN: J. DETTWILLER, MN/RE
77 RUE DE SEVRES
92106 BOULOGNE-BILLANCOURT
CEDEX, FRANCE

OZEANOGRAPHISCHE
FORSCHUNGSANTALT BUNDESWEHR
LORNSENSTRASSE 7, KIEL
FEDERAL REPUBLIC OF GERMANY

INSTITUT FUR MEERESKUNDE
AN DER UNIVERSITAT KIEL
DUSTERNBROOKER WEG 20
23 KIEL
FEDERAL REPUBLIC OF GERMANY

INSTITUT FUR MEERESKUNDE DER
UNIVERSITAT HAMBURG
HEIMHUDERSTRASSE 71
2000 HAMBURG 13
FEDERAL REPUBLIC OF GERMANY

DIRECTOR, DEUTSCHES
HYDROGRAPHISCHES INSTITUT=
TAUSCHSTELLE, POSTFACH 220
02000 HAMBURG 4
FEDERAL REPUBLIC OF GERMANY

ISTITUTO UNIVERSITARIO NAVALE
FACILTA DI SCIENZE NAUTICHE
ISTITUTO DI METEOROLGIA E
OCEANOGRAFIA, 80133 NAPOLI -
VIA AMM, ACTON, 38 ITALY

CONSIGLIO NAZIONALE DELLE
RICERCHE
ISTITUTO TALASSOGRAFICO DI
TRIESTE, VIALE R. GESSI 2
34123 TRIESTE, ITALY

DIRECTOR, SACLANT ASW
RESEARCH CENTRE
VIALE SAN BARTOLOMEO, 400
I-19026 LA SPEZIA, ITALY